CONSERVE & RENEW

An Energy Educational Activity Package for Grades 4-6

CALIFORNIA ENERGY COMMISSION

MARCH 2003
180-03-002F

Gray Davis, *Governor*

Conserve & Renew

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Revised and reprinted in 2002 by:

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WELCOME!! an introduction

OBJECTIVES: All you hard-working teachers (yes you!) and all of your students will have a good time learning about energy conservation and renewable energy resources.

SUMMARY: This manual is a collection of energy education activities that are written and organized to be used either as a unit on energy or as individual activities to complement existing curricula. The focus is on conservation and renewables because these important aspects of energy education have not received as much curricular attention as the more "traditional" sources of energy.

GROUPING: Most of these activities are designed as cooperative learning experiences. You can also use them as full-class exercises of individual work. You might even combine classes with another teacher. Most activities are written to offer options, and others can be easily adapted.

TIME: There is wide variation in the time requirements. Some activities can be done in 30 minutes; others involve weeks of data collection. Some of the long-term projects can be adapted to be completed more quickly.

SUBJECTS: Virtually every discipline is addressed in these activities. Studying energy lends itself well to both problem-solving and critical thinking. Because energy is something that permeates every aspect of life, it can be wonderful motivator for getting students engaged in their projects in all the traditional disciplines.

VOCABULARY: Each activity has some vocabulary words noted. These are not only energy terms; usually general vocabulary is addressed. If you would like some help with the energy terms, please see the glossary.

MATERIALS: Most activities have been designed so that elaborate or unusual materials are not required. You can do these activities with readily available materials.

PREPARATION & BACKGROUND: No one needs to be an energy expert to use these activities! Just be ready to have a good time and learn about energy. The background information necessary for each activity is presented.

We really think you teachers are great! Teaching your students about energy today prepares them for tomorrow! We hope you, too, will enjoy learning about energy along with your students. If you need more information, in the references section at the end of the packet, you will find a selection of materials that will provide further detail. Be sure to look at the annotated bibliography for software sources, movie catalogs, more activity books, and some very informative energy books that can help you expand your energy units and increase your content knowledge.

ALSO:

1. Read through each activity carefully before trying them out at school. You are the expert on how your class will react to activities.

2. Take the students outside as often as possible for the activities — make use of the sunlight. Close the door and turn off the classroom lights as you leave!

3. Make sure students of varied ability are in each group — that is the best learning atmosphere for all.

4. It is often a good idea to ask yourself and the students, "What are we learning here?" as you do each activity. This question will help focus the educational value of the activities and unexpected lessons can be discovered along the way.

5. Give us the benefit of your expertise. We would greatly appreciate feedback on how to improve the packet, on how you successfully adapted these activities, or on other ways we can help you and your students learn to "Conserve and Renew." A feedback form follows the Annotated Bibliography.

FOR DISCUSSION: The questions found under this heading in the activities are designed to encourage higher-order thinking and allow success for all the students at the same time.

1. Do you want some help getting some science into your curricula?

2. Do you think it is important to inform your students about energy today so they might be better-prepared for the energy-scarce future they are certain to encounter?

3. Are you interested in finding out where energy is wasted each day?

4. Does saving energy and money at home and at school seem like a good idea?

5. Would you like to learn more about renewable energy and its advantages?

EXTENSIONS: Be sure to take a moment and look at the extensions; they are often full of great ideas. When your students are really enthralled, you can look here for ways to expand the activity and continue their enthusiasm.

1. Take an extra field trip with all the money that you save for your school.

2. Join N.E.E.D. and your class can compete for a trip to Sacramento or even Washington, D.C.

3. Take some of the information you have gained school wide and help other classes save energy, too.

4. Have your students help a primary grade with some of the easier activities.

5. Have your class teach about conservation at a PTA meeting or a senior center.

6. Come use the Sonoma State University Energy Curriculum Library (707) 664-2577!! All of the items in the bibliography (and many, many more) are available there.

7. How about doing an in-service on how to integrate Energy Education into the curriculum.

READY?

This activity packet is organized into six sections:

1. What is Energy?
2. Renewable or Nonrenewable?
3. Net Energy, The Second Law of Thermodynamics
4. Energy Conservation
5. Recycling
6. Energy Ethics

SET......

If this manual is your students first encounter with energy education, we recommend that you start with the first section. From there, you can move through the sections in order or pick and choose activities that complement your lesson plans, teaching style and objectives. On the title page to each section, you will find an bit of background information and explanation of what we hope you and your students will gain from the activities. At the end of each activity in that section, some paper and pencil activities relate to the activities in that section.

TEACH!

And best wishes to all of you for some "energetic" and educational fun.

A. WHAT IS ENERGY?

These activities introduce the students to what energy is and what it does in the world around us. Energy is not a word that is simply defined to a 4^{th} grader (try it right now!)

These activities will get the students thinking about energy by having them use the term in relation to tangible examples of energy in their lives. By using the term, experimenting, and making observations, the students will gain an understanding much deeper than having memorized the classic physics definition: "Energy is the ability to do work."

In the activity "Detective," students generate a definition of energy, based on observations made at school. Next, a set of activities introduce various energy sources. The activities "Solar Collectors" and "Food Chain Gangs" illustrate solar energy in the natural world and how it relates to humans. Finally, as in all sections, pencil and paper activities focus on energy.

eNERgy

DETECTIVE

MOTION

OBJECTIVES: Awareness of the energy around us everyday will be increased.

SUMMARY: Students will look for energy, collecting "energy evidence," and then come up with their own definition of energy.

GROUPING: 4-6 per group.

TIME: 40 minutes.

SUBJECTS: Science, language arts, social studies.

VOCABULARY: Energy, investigate, motion, evidence.

MATERIALS: Copies of Detective Data Sheet and copies of extra clues.

PREPARATION & BACKGROUND: Make sure you have enough copies of the Detective Data Sheet to give one to each group. You will also want to copy and cut up the list of extra clues. This can be a puzzler for students at first, but once they get going it can really take off!

A definition of energy is "The ability to do work." Students probably will not come up with this precisely, but they will have a better understanding of what energy is and what it does. Start a discussion by asking, "What is energy? Who needs it? Where do we get it?" Get the students to list different energy sources they are familiar with: electricity, gasoline, nuclear, food etc. They may want to look up the definition in a dictionary. An example of evidence would be a flag flying =

wind energy; or a warm desk in the sun = sun (solar) energy.

PROCEDURE:

1. Divide the class into groups. Each group represents a detective agency, searching for the answer to "What is energy?" One of the students can be secretary and record the group's findings.

2. Based on the clues in the handout, students go in search of evidence that will help them find the answer. They can come to you for more clues if they think that they need them. You can give clues out one at a time to individuals or give the group the entire list. If the students seem lost or confused, go over the data sheet with them.

3. When they have collected their data, have each group come up with a definition. They can choose the best from the group or makeup a conglomerate definition.

4. Have each group share their definition with the rest of the class.

We think energy is.........

FOR DISCUSSION:

1. What kind of energy helped you do this activity?

2. Can you feel energy?

   See energy?

   Hear energy?

Energy is the ability to do work!

EXTENSIONS;

1. Talk about the physics definition, "Energy is the ability to do work," and relate this to the definitions the class came up with.

2. Make up a list of clues that you can find at home that support the definition, "Energy is the ability to do work."

Extra Clues for Puzzled Detectives

1. Electrical and solar energy give us light.
2. Sun energy grows our food.
3. Lightning is a natural form of electrical energy.
4. Gasoline, made from crude oil, gives us energy to make cars go.
5. Energy heats our homes and school.
6. Energy keeps our refrigerator cold.
7. Sail boats need wind energy.

cut here

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DETECTIVE DATA SHEET

NAME ____________________________ DATE ______________________

CLUES

1. Energy can make things change.
2. Heat comes from energy.
3. Movement comes from energy

EVIDENCE

We know that energy was here because.........	Energy Source? (sun? wind? electricity? other?)

REPORT FROM THE ____________________ DETECTIVE AGENCY

After you have collected energy evidence, have each person in your group make up a definition for energy. Write definitions in the spaces below.

Next, have your whole group agree on one definition and write it at the bottom of he page.

DETECTIVE NAMES	DEFINITION OF ENERGY

GROUP ANSWER: WHAT IS ENERGY? . . . . . .

E V I D E N C E

INVESTIGATE

SORT ACTIVITIES ON

ENERGY SOURCE'S

SOLAR

First have students brainstorm all the ways that solar energy is used every day (daylight, warmth, grow plants, drive wind, form clouds for rain.) and list these on the board. We take the sun for granted usually— just think what our heating and lighting bills would be without the sun! Have students write a story or make up and perform a play titled, "The Day The Sun Didn't Shine."

Place a tape "X" on a classroom window. Note how the shadow moves through the room during the day and over the passing of the school year. Relate to the students how the sun in higher in the sky in the summer. Talk about how a passive solar house designer could use this phenomenon to help heat a house in the winter and keep it cool in the summer.

WIND

Make different size kites and compare how hard each pulls on its string.

Make a model sail boats and discuss how people used to (some still do) depend on the wind for ocean crossing. Has anyone seen a windmill? They use wind power to pump water and generate electricity. Has anyone ever held their coat open and sailed on their bikes?

HYDRO

Make a hydro-mill by cutting little doors lengthwise into a plastic soda bottle and bend the doors open. Insert a dowel into the neck of the bottle as an axle. Fasten a string to the neck of the bottle. You can tie objects to the other end and the mill pulls them in as the string rolls up. You can pour water over the mill to make it turn. Use a pitcher and catch the water for reuse in a dishpan below the mill.

Have students research where the hydroelectric plants are in the U.S. or just in California. Have them draw a map indicating these locations and how much electricity they provide. Other energy sources can also be drawn in.

NUCLEAR

Split the class in half: they will be pro-nuclear and anti-nuclear advocates in simulated debate. Have them research and collect current articles supporting their potential arguments. They can do library research, collect newspaper articles, and write letters to utilities and environmental groups requesting information.

The students can write letters and create drawings that state their new, informed opinions when they've completed their research and debate. Letters can be sent to local politicians, the President, utilities, or local and school papers.

OIL

Make a timeline that shows the historical period when the plants and animals lived, that ultimately have become oil. Show how long it took for these living things to be transformed into oil. Then compare it with how long it is taking humans to burn it all up.

Have the class brainstorm a list of all the ways we use oil in our lives. Talk about the alternatives to these uses of oil (e.g. cycling or walking instead of getting a ride in the car, reusing old plastic bags). See how many of the alternatives the class can do for the school year.

COAL

Bring muffins or cookies to class that have nuts and /or raisins in them. Have students mine for the goodies (representing coal and/or other mineral deposits) with a toothpick. Discuss what happened to landscape as they mined.

GEOTHERMAL

Use a teakettle, and let the steam turn your hydro-mill (see hydro in this section). You can also make pinwheels to catch the driving steam.

Talk with students about the core of the earth. Take a field trip to a warm springs (like Calistoga) and swim.

NATURAL GAS

Divide class into groups. Each group will be asked to research and report on questions like: Where is natural gas from? What do we use natural gas for? How was natural gas discovered? How can we conserve natural gas?

Have each group present their findings to the rest of the class in a creative way.

ELECTRICITY

Have the class create a diagram that shows where the electricity that lights the school comes from.

Have students list uses of electricity in their school or home and then talk to an older person and ask them what they used electricity for as a child. What did they do in place of all the things we use electricity for?

SOLAR COLLECTORS

OBJECTIVES: Given a physical example of how plants seek the sun; students will understand the need plants have for sunlight.

SUMMARY: Students will grow seedlings under varied light conditions and observe the varied growth effects.

GROUPING: 4 students per group.

TIME: 3 hours spread over three weeks.

SUBJECTS: Science, language arts, math, art.

VOCABULARY: Photosynthesis, solar, germinate, seedling.

MATERIALS: Seeds, soil, planting containers, watering containers, plates or pans to catch drips and sunny seed data sheet for each student.

PREPARATION AND BACKGROUND: Collect all the materials. You'll need enough seeds so that each group can plant three. Radish seeds grow quickly; peas, beans, and limas work well also. Recycled egg cartons will work for planting containers. If you use styrofoam egg cartons or some other watertight container, be sure to poke a hole in the bottom to prevent "soggy seed rot." You can also get containers at a nursery. You may want students to save egg cartons for a couple of weeks or ask at a bakery. Potting soil works best, but ordinary dirt will often give satisfactory results if care is taken not to over-water. Pump spray type bottles work best for watering.

Because plants need light to provide the energy for photosynthesis (production of food for the plant growth and regeneration) seedlings will grow toward light. Seedlings grown in the dark will become long and spindly trying to find the light they need. Seeds with access to the sun will turn their leaves in the sun's direction to maximize solar exposure. Given sun, water, air, and soil, plants can photosynthesize, which allows them to grow. This is of particular importance to humans, because we are not able to use the sun's energy this way. We depend on plants to convert sunlight, carbon dioxide and water into complex molecules so that we can eat them for our bodies' energy.

SOLAR

photosynthesis

germinate

PROCEDURE;

1. Tell the class they are going to explore the relationship of light and plants. Each group will grow three plants in varied light conditions: part sun, full sun and darkness.
2. Have the students plant their seeds according to the directions on the package. They need to put their potted plants on a dish to hold any overflow water. They should also set the plant so that it maintains the same plant position and light exposure throughout the experiment. This is most easily accomplished if they are set in place once and not moved during the three weeks of growing time.
3. Each group should have three plants — one in the fullest sun available, one in part sun, and one in the dark.
4. Students are to fill in their data sheets over the next three weeks. They should share duties and keep accurate notes on the progress of each of their seedlings. At the end of the three weeks (you may want to continue this for longer), everyone can compare lab notes to see how light affected seedling size and shape.
5. Have students compare the average size of all the plants grown in the sun, shade and dark.
6. To finish up the activity, have students tidy up their data and do a complete write up of the experiment.

FOR DISCUSSION:

1. Why do plants need the sun?
2. What can plants do that humans cannot do?
3. Can you think of a plant that likes the dark? (Mushrooms)
4. Have you ever turned over a rock and seen yellowish plants with long stems? Why do they look this way?

EXTENSIONS:

1. Have students research germination in the library and write up a report.
2. Have one group turn their plant container little bit each day. How does this plant look?
3. Look at the plants around the schoolyard: do they reach around the shadows for sunlight?
4. Plant the seedlings in a garden outside or in larger containers and harvest a crop or make gifts of them.

SUNNY SEED DATA SHEET

NAMES

1 ______________________________

2 ______________________________

3 ______________________________

4 ______________________________

5 ______________________________

Data for Week # ______

seedling

MONDAY	WEDNESDAY	FRIDAY	TOTAL GROWTH FOR THIS WEEK
Full sun seedling height ______	height ______	height ______	
Attach a drawing and written observations of each seedling for each day.			
Part sun seedling height ______	height ______	height ______	
Attach a drawing and written observations of each seedling for each day.			
No sun seedling height ______	height ______	height ______	
Attach a drawing and written observations of each seedling for each day.			

interdependence

FOOD CHAIN

FOOD CHAIN GANGS

OBJECTIVES: Students will understand how energy is passed through trophic levels, starting from the sun.

SUMMARY: Students will place themselves into food chains based on link cards that they have been given.

GROUPING: 4 or 5 per group.

TIME: 30 minutes.

SUBJECTS: Science, language arts.

VOCABULARY: Trophic, food chain, interdependence.

MATERIALS: Food chain cards.

PREPARATION & BACKGROUND: Familiarize yourself with the food chains; some are tricky! (hint: Because mosquitoes eat blood of mammals, they can fill a higher trophic level in a food chain than say a horse.) Cut the cards up, and ask students to color them in, and think about where the item on their card gets its energy, and who it might become energy for.

Food chains illustrate the relationship between plants and animals. All plants depend on the sun, and all animals depend on plants (except a very special group of plants and animals that live deep in the ocean at the Mid-Atlantic Ridge). The lower down in the food chain a plant or animal is, the lower trophic level it fills.

If you don't have an even number for groups of 5, you can omit the last card from one or more of the chains.

TROPHIC

PROCEDURE:

1. Discuss food chains with students. Do an example on the board, and discuss what type of energy each member of the sample food chain eats, and where that energy (food) came from.

2. Distribute Food Chain Cards. WITHOUT SPEAKING, the students are to find the other members of their food chain and line up in order.

3. Once everyone has found their place, have each group share what they are and how they fit in their food chain.

FOR DISCUSSION:

1. Have students explain a food chain using themselves and their lunch in the explanation.

2. How many plants or animals from the lower trophic levels does it take to support those at the higher trophic levels?

3. What happens to the rest of the chain if one "link" of the chain gets wiped out by insecticides, pollution, or extinction?

EXTENSIONS:

1. Have your class figure out a food chain they might be able to have in the classroom. Examples include plants-aphids-lady bugs or grass-cricket-lizard.

2. Have students do a creative writing project that traces a bit of energy through a food chain.

3. Students could do a diorama or poster that illustrates food chains indicating links with yarn or string.

4. Discuss with the class things that can interrupt a food chain, make up "chain breaking" cards and incorporate them in the chains.


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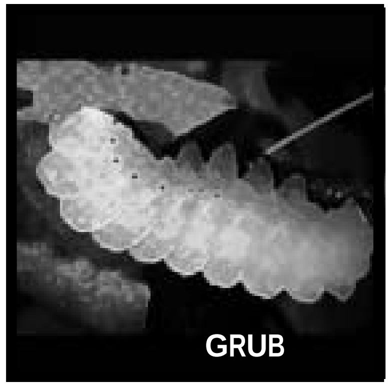
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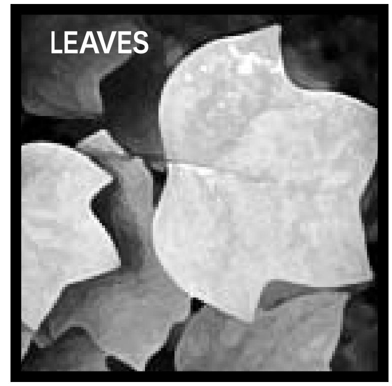
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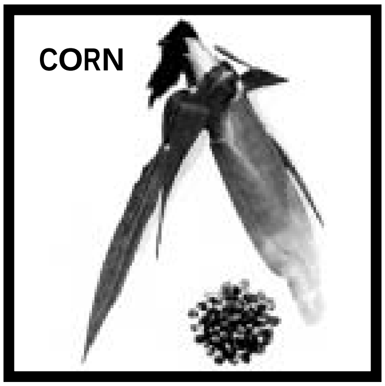
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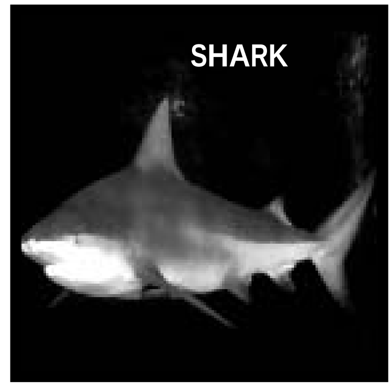
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BIRD

RACOON

MOUNTAIN
LION

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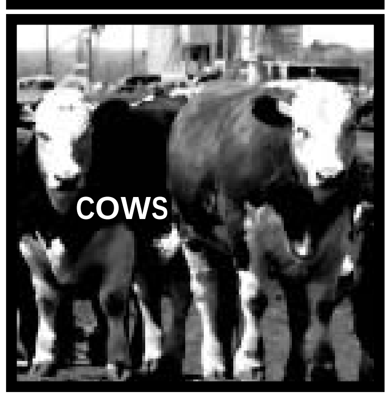
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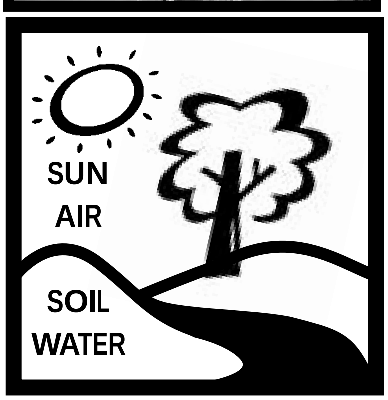
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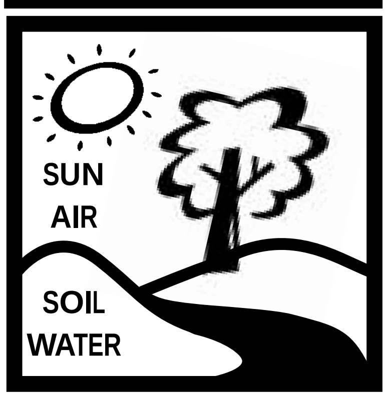
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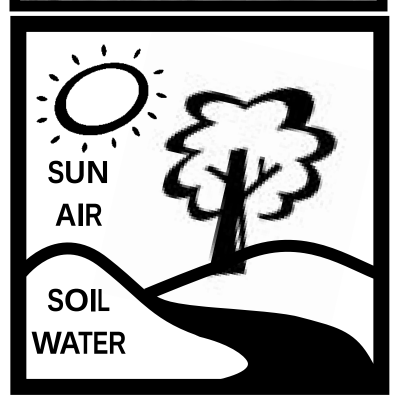
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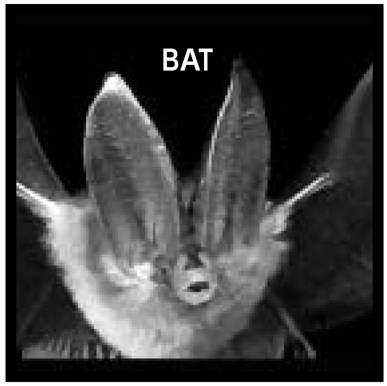
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RAT

GRASS

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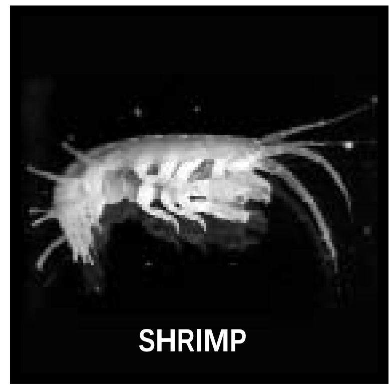
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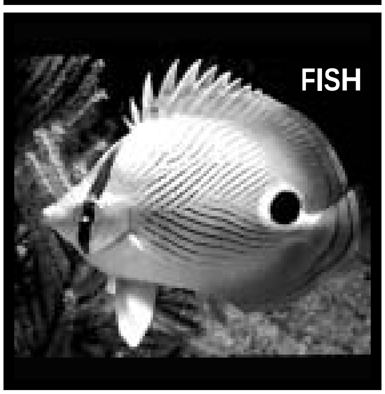
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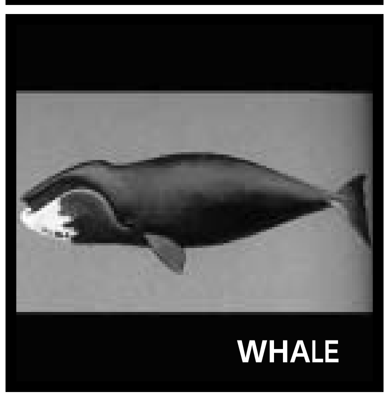
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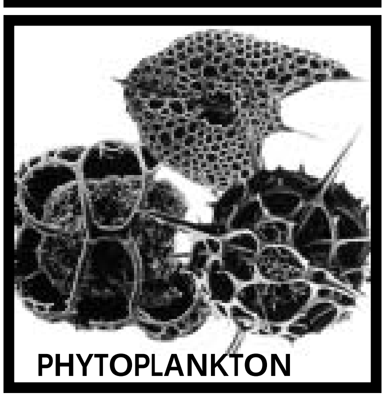
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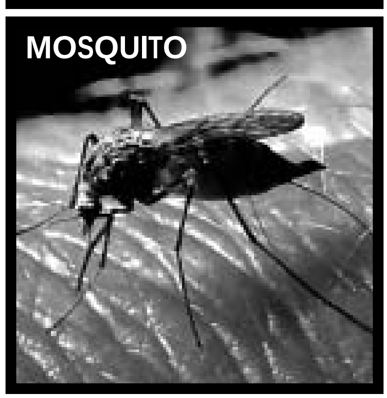
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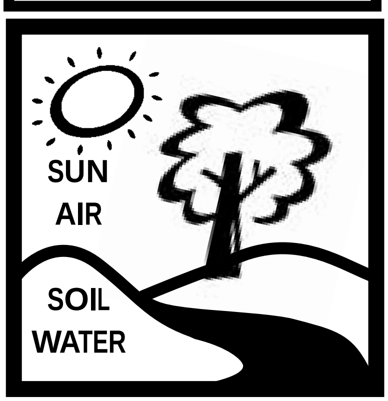
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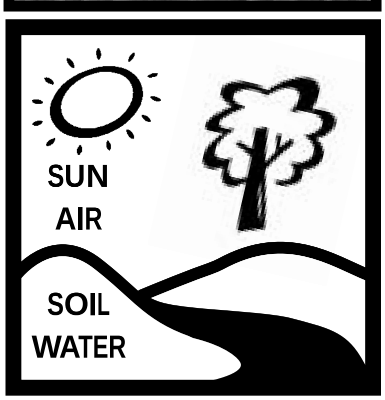
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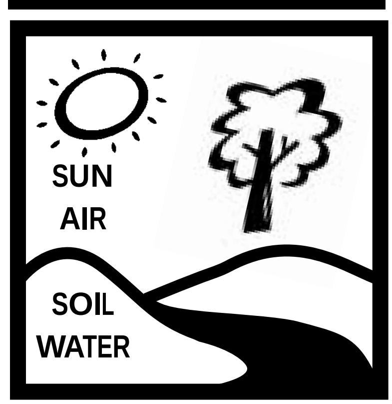

SUN
AIR
SOIL
WATER

PENCIL AND PAPER ACTIVITIES

NAME ______________________________________ DATE ________________

DIRECTIONS: Write the right homonym in each space.

1. If we (waste, waist)____________our natural resources, the supply will run out.
2. Fossil fuels will (not, knot)_________ last forever.
3. This is because (knew, new) ____________fossil fuels are not being made as fast as we are using them.
4. People are learning how to store solar energy (sew, so) _________ we can use it.
5. We (know, no) _________ that geothermal energy comes from the heat of the earth.
6. Burning coal produces a (grate, great) ___________ amount of pollution and contributes to acid rain.
7. Some people (see, sea) ________ nuclear energy as the power source of the future; (sum, some) ________ people think it is much too dangerous.
8. Water from dams, flowing (threw, through) __________ turbines creates hydroelectricity.
9. Using energy wisely is the best (weigh, way) ____________ to conserve energy.
10. People who recycle are helping (their, there, they're)_______________ environment by saving energy and resources.
11. Do you know (wear, where) ______________ a recycling center is?
12. (Which, Witch) ____________ recycling center is closest to your school?
13. Ask the (principal, principle) ____________________what our school does to save energy.
14. Recycling, conservation and using renewables are (awl, all)__________ good ways to make sure that we will have energy to use in the future.

NAME ______________________________ DATE ______________

Antonyms are words that have opposite meanings, like hot is the antonym of cold. In each sentence below, a word is missing. The word that is in parentheses is the antonym of the missing word. You must write the correct word in the blank. If you are stuck, look

at the list of words at the bottom of the page; the correct words are listed.

1. Plants are (worse) __________ at using the sun's energy to grow than people are.

2. Solar energy can help to keep our houses and classrooms (cool) _________.

3. When we are exercising, we are using (less) ______________energy than when we are sitting.

4. Leaving lights and the TV on when we do not need them (saves)_________ energy.

5. We can save energy at school by being sure to keep windows and doors (open) __________ on very cold days.

6. Oil is a very important energy source that is (needless) ____________ for making gasoline.

7. Electricity is the (least) _________expensive source of energy that we use at school.

8. People are sometimes (careful) ______________ with energy because they (remember) __________ that it is (unimportant) ____________ for our (past)______________.

most	future	better	careless	important	wastes
more	closed	necessary	forget	warm	

B. Renewable OR NONRENEWABLE?

These activities give students the opportunity to see what renewable energy sources are and how they are used. Even the oil companies agree: we are running out of oil. The U.S. reserves will run out in the next 30 years; world reserves are only ten years behind. Burning coal has proved to be environmentally hazardous. What will we do without these nonrenewable energy sources? Thankfully, most estimates are that the sun, wind and gravity will be around for quite awhile. The energy sources of tomorrow are likely to be renewables.

The activity "Energy Talks" is a drama that teaches which and how nonrenewable energy sources are being depleted. It is a good introduction to understanding what the terms renewable and nonrenewable mean. The "Renew-A-Bean" activity graphically shows how renewables will become more and more prevalent in the future. "School Energy Map" is a tangible way of understanding how we use energy on a daily basis, evaluate where that energy comes from, and discuss ways of meeting those energy needs in another way. "Energy Source Dominoes" is a thought-provoking yet simple game for reviewing energy sources in light of their renewable and nonrenewable qualities. This game can challenge and allow success for all players.

ARCHITECT

biofuel

ENERGY TALKS

OBJECTIVES: Given the opportunity, the student will be able to understand what a nonrenewable resource is and its limitations.

SUMMARY: Students participate in a play with resources as characters.

GROUPING: 9 speaking roles, director, stage hands, costume crew, prompter

TIME: 45 min - days.

SUBJECTS: Social studies, art, science, vocations.

VOCABULARY: Nonrenewable, petroleum, generating, metallurgist, geologist, architect, biofuel.

MATERIALS: 10 copies of the play, props and costumes.

PREPARATION AND BACKGROUND: Brainstorm with the students various energy sources used during the course of the day. Identify which ones are renewable and nonrenewable, defining those terms as you brainstorm. The sun will not actually last forever, but for the purposes of the definition, solar energy is considered renewable; it also gets tricky when you talk about electricity. Is it solar electricity or nuclear? The first is considered renewable; nuclear is not. Here are some good working definitions:

Nonrenewable resource: Resource (such as oil, coal, gas, natural gas, uranium) that is not reusable or not naturally replaced as quickly as we use it up.

Renewable resource: Nondepletable resource that we cannot use up, such as the sun, or a resource that can be replaced, such as biofuel.

Review the roles of the nonrenewable resources in the play, keeping these definitions in mind.

EXTENSIONS:

1. Have students make up a similar play, only with renewable resources as characters.

2. Get the students to create commercials for energy sources and perform them before and after the play.

ENERGY AND RESOURCES TALK

This play can be produced on a stage, complete with props and scenery. With some modifications, it can be done as a radio program that is broadcast on the school intercom, on local public radio, or taped and played back to the class.

CHARACTERS:

Aluminum	*Coal*
Copper	*Iron*
Natural Gas	*Crude Oil*
Cathy	*Jason*
Announcer	*Voice of parent*

ANNOUNCER: In this adventure, Cathy and her brother Jason happen upon some nonrenewable resurces waiting to be put on display in the workroom of a museum. Nonrenewable resources are energy sources, like oil, that are used up faster than the earth can replenish them. Here, behind the scenes at the museum, the resources are having a discussion — yes they are talking — about their importance to people and what futures hold. (Each of the resources is laying about the workroom - on a table, in an open cupboard or on a shelf with label marking them.

COAL: I am most important, so I should be in the front of the display!

CRUDE OIL: No, I should be in front; I'm the most important!

COPPER: Wrong again, it should be me!

IRON: You're both wrong! I am much more important.

ALUMINUM: But what about me? You forgot about me!

NATURAL GAS: Maybe they could just sort of line us up in a row, so no one is out in front?

CRUDE OIL: That sounds good, as long as I'm first in line.

COAL: Did you know that most of the electricity in the United States is produced by burning me, Coal? That means, I am used for the lights here in the museum, and every time some one listens to music on the radio or tape player, they are using electricity that came from me. You know lots of the fancy machinery in hospitals run on electricity too. I make that possible! I'm used to heat homes in some parts of the world; I keep people from freezing to death in the winter.

ALUMINUM: Yeah, that sounds pretty important, but they can make electricity in other ways if people set their minds to it. I, Aluminum, have become more and more important as time has gone by. Why? Many people's homes have windows and doors that are made of me; it would be hard to find a home, office or factory anywhere in the U.S. that doesn't use me in some way. I have become important in many types of industry as a light, strong building material. All the electricity Coal

Continued on next page

produces has to run through wires, and I am sometimes used for making inexpensive wire.

COPPER: Well, I do an even better job of carrying electricity than Aluminum does; that is why people will pay extra for my Copper wire. I have been around for hundreds of years as an important metal. Why, you can find me in the money people use everyday. I've taken the place of silver because she has become so hard to find.

IRON: Yeah, well I'm important for the buildings that humans use all the time. This museum building relies on me, Iron, to hold it together. I am in foundations and in the girders that hold up hospitals, schools, stores and most other buildings. Cars and other vehicles rely on me. Where would humans be without cars, trucks, trains and buses?

CRUDE OIL: You are right, I don't think people think about how they would get to school, work, the doctor's office of home if they didn't have their vehicles. But even if they had plenty of cars, they couldn't go anywhere without me. You know, more than on fourth of the energy used in the U.S. is used for transportation. That means me, Oil.

NATURAL GAS: Well, people have recently been turning to me more and more. They have discovered that burning me, Natural Gas, produces a lot less pollution than some other burnable fuels. I can really help by saving people money when it comes to cooking and heating with gas instead of electricity. I'm used in other ways, too, like in manufacturing drugs, detergents and plastics. (Cathy peeks into the room curious and a bit scared. Her brother Jason pushes past her and stands inside the doorway. They slowly enter as they talk and don't notice the resources' conversation taking place on the other side of the room.)

JASON: Hey what's in here? Looks like where they set up displays for the museum.

CATHY: Shhhhh! We aren't supposed to be in here! But as long as we are, maybe we can just look around a minute. I would love to work in a museum someday. Isn't this exciting!

JASON: Not exactly. Skateboarding off a sea cliff at 50 miles per hour, landing on a perfect wave and riding it in — now that would be exciting! Come on, Mom and Dad will wonder where we are. Besides, I want some lunch!

CATHY: Their watching that video on ducks again, and it won't be over for awhile. Let's look around — just don't touch or break anything! Wow, I would love to work back here with all this cool stuff.

(Jason shrugs and gazes around kind of bored.)

ALUMINUM: We are all so important — that must be why they are putting us on display together.

COPPER: Well, it's sort of like that. We're going on display as nonrenewable resource.

IRON: Non-re-what-able? I don't know what that means.

Continued on next page

COPPER: Non-re-new-able. We are all natural resources being used up faster than the planet can make us.

(Cathy notices the conversation and elbows Jason, who has been gazing around the room and playing air-guitar. She motions to him to stay quiet and points towards the resources.)

CRUDE OIL: Yes, and it took millions of years to make us and only hundreds of years to use us all up. I just wonder what people plan to do when we are all used up?

(Jason and Cathy look at each other in surprise. Jason turns to leave, but Cathy grabs his coat and walks over toward the resources, dragging him along. They stop and hide at the edge of a large desk (or table, or bookcase, or cupboard), peek around, and listen some more.)

NATURAL GAS: Yeah, me too! I don't think people have even begun to realize what we do for them, and what will happen when we are gone. Why, I help heat homes, cook food, help to run factories, dry clothes, heat water, and many more things. If people aren't careful, they will all have cold homes, cold and raw food, no jobs, and cold showers, soggy clothes — not to mention a lot of other things.

JASON: (Quietly to Cathy as they peek around the table) Cold showers, Cold pizza! Raw hamburgers! Yuck! What are they talking about?

CATHY: This is exciting and weird, talking museum displays!

COAL: I'd like to see people use me wisely. The jobs I do are important, and it is not fair to the people who will be around in the future to waste even a little bit or us resources or our energy.

CRUDE OIL: Yeah, the kids of today may not be able to drive cars around like their folks, if no one learns to use me more carefully.

CATHY: (She stands up, walks over and talks angrily to the crude oil). What do you mean, I won't be able to drive around in a car? I want a convertible of my own to go where I want. It's not fair if I don't get to drive! (She stops a second and looks to the audience.) Look at me, I'm talking to some oil! I must have really flipped! I must have really flipped! (She turns back to the resources.) Are you really talking to each other?

COAL: We sure are, and you are just whom we need to talk to. Do you humans know that we are being used up, and quickly, too? We aren't sure if you humans know what you are headed for; life won't be the same when we are gone.

JASON: (Picks up a large label for the display and reads it). Nonrenewable resources. Is this the name of the display you're going to be in. Is that what you are talking about, nonrenewable resources?

GEOLOGIST

Continued on next page

COAL: Yeah, and it's a very important display. Did you know you rely on nonrenewable resources everyday — for lights, to make buildings, for medicines, to drive cars, to grow food and make your clothes. We do so many things; it would take forever to list them. We're worried because humans don't seem to realize that we are being used up. Pretty soon there won't be any of us left, and then you will really be stuck!

CATHY: I sure never thought I'd be talking to a hunk of coal. My folks used you for years to heat our home, but I certainly never carried on a conversation with you before!

COAL: That's the whole point! You've used us for years, but you never stopped to think and understand what is happening to us. Do you realize that all of us in this display might be completely used up? Gone?

JASON: Big deal! So what? Scientists have saved us before, so why can't they do it again? We don't need you because I'm sure we'll find something else to take your place.

CRUDE OIL: This could very well be, but I wouldn't count on it. Scientists are now working on all sorts of forms of renewable energy, such as geothermal, solar and wind energy, but they all have problems that have to be worked out. Right now, humans still need to use oil to tap these new energy sources. Besides, what you and so many other people don't realize is that all of us are used in a lot more ways than you can even imagine. Did you know that I'm used to make fertilizer to grow your food and in plastics for records, computers and all sorts of products? Without me, out factories couldn't even run to make things.

ALUMINUM: Yes, and did you know that I'm found in such things as doors, engines, car parts, boats, bicycles, street signs, mobile homes, and many, many more things you haven't even thought about? Can you imagine how hard it would be to even start to find a replacement for all these things?

IRON: Yes, and do you realize how many jobs or industries we provide for people? Why, we provide jobs for all sorts of workers, including your parents, and just about any job you hope to have someday.

COPPER: Hey, how about me? I carry electricity from generating plants to all our homes, schools and businesses. I just wonder what will happen to people if all of us are used up. Do you have any ideas at all about what is going to happen? Sure doesn't sound like a lot of fun to me!

JASON: I never really thought about it before, but I just always thought that science would invent anything we needed. I never thought that maybe we would run out of the things we need to invent new things Guess that is worth thinking about. That would be a real drag.

CATHY: You're right, and it's about time we started thinking about it, and more importantly, doing something about it. (Turning to the non-renewable resources.) Can you make some suggestions on how we could help out with this problem?

ALUMINUM: Yep, I've got one. Instead of throwing away things that are made out of aluminum, like soda cans, old foil, and aluminum doors, save them and recycle them. You know, most cities have recycling centers where you can sell me back to be used over and over. Just think, you would be doing a good deed and getting money for it at the same time!

COAL: You can make me last longer by being very careful about using electricity. Don't run electrical appliances when it isn't necessary. Turn off lights and the TV when you leave a room. Turn down your thermostat, and keep your house well insulated, so heat won't escape. Never use electrical power unless it is really necessary. I'm sure you can come up with of lots of other ways to conserve if you really think about it.

CATHY: Yeah, our folks are always saying we should turn off lights and the TV to save money. I'll be more careful now that I know it is so important to also save energy.

COPPER: I can also be recycled or used again, like aluminum. I really wonder how much of me can be found in old junkyards and garbage dumps. I know it is easy to sell me to recycling centers these days, and you'll get a lot of money for me, too.

IRON: I can be recycled, too, and made into brand new things, like car parts and parts for almost all kinds of machines and equipment. Car wrecking yards recycle me.

NATURAL GAS: I can be conserved in the same way coal is — by being very, very careful with the things I help run. For instance, people can save natural gas by always running a full load of clothes in the clothes washer and by hanging their wash outside to dry when possible, instead of running their gas dryer. You can save natural gas by always making sure your gas appliances are in perfect running order. Turning down the temperature on your water heater can keep small children from getting accidentally scalded, and save energy and money at the same time.

JASON: That's a great idea! I hate it when the water is too hot when I'm washing dishes.

CATHY: You hate anything that has to do with washing dishes!

CRUDE OIL: I guess most people think of me when they think of cars and trucks, but I also do lots of other jobs, They make liquid gasoline, oil, and kerosene out of me. I help all kinds of machines work, I oil hinges in doors, and I run cars. If people drove 55 mph only drove their cars when it was necessary, and rode in carpools or on mass transit to work, it would really help conserve me. I think we all agree that we must all help to conserve, because when everyone works together things always seem to work out a lot better.

Continued on next page

petroleum

CATHY: Yeah, I agree totally. If we are careful now, then maybe we will have it easier when we have kids someday. I would hate to have to wash clothes by hand with only cold water.

JASON: Well, I know one thing, I'm going to do all I can to help because I sure don't want to lose all these helpful resources. I don't think I'll just count on the scientist now that I understand the whole issue a little better. I guess it's up to all of us, not just other people. I wish I had started sooner, but it's not too late to get started right away. I think I'll start riding my bike more instead of asking for a ride, and I know I can find lots of cans and bottles to recycle.

CATHY: Yeah, it's not too late, and individuals really can make a difference. If we all do our part and work together, we still can have some of the great things these nonrenewable resources provide in the future. I can turn the TV off between Nintendo games and be sure not to leave light and other electrical appliances on. I think I'll start conserving as much as I can, and just be more careful with energy in general.

COPPER: I think this display is already teaching people, and we haven't even gotten out of the workroom!

Maybe they should put our display right in the front of the museum.

(We hear the voice of one of Cathy and Jason parents on the other side of the door. Saying, "I think Jason and Cathy went over to the geology section while we were watching to video. Let's look over there next." Jason and Cathy look at each other, turn and wave to the resources, then dash out the door. Jason returns and turns off the lights.)

the end

nonrenewable

metalurgist

depletion

rate-of-use

DEVELOPMENT

RENEW-A-BEAN

OBJECTIVES: Students will increase their understanding of the eventual depletion of nonrenewable resources, the effect of changing rates of use on the future, the role of conservation and the need to develop renewable resources.

SUMMARY: Beans will be used to represent renewable and nonrenewable energy is a situation where use over several years is simulated.

GROUPING: Entire class in 5 groups or all together.

TIME: 30 minutes.

SUBJECTS: Math.

VOCABULARY: Depletion, development, rate of use.

MATERIALS: 5 clear jars, lots of beans, 93% one color, 7% another color, say pinto and garbonzo beans or peanuts and almonds or ???????? (have a 93.7 ratio to represent the ratio of nonrenewable to renewable energy consumption in the U.S.).

PREPARATION AND BACKGROUND: Prediction of how long various energy resources will last is risky at best. In the early 1970s, it was predicted that we would run out of natural gas by the late 1980s! In the 1950s, utilities predicted we would need a nuclear power plant every 10 miles along the California coast to meet our electrical energy needs! It is important to know whether a prediction assumes a constant rate of use or a changing rate. It is also important to know whether a rate assumes that more resources will be found or it assumes use of only known reserves. It is also important to consider if foreign resources are included.

The point of this activity is not so much to show the actual numbers, but rather that nonrenewable resources will be depleted, and the conservation (reduction of waste) together with the development of renewable, resources can extend the availability of non-renewable. It may help you to check the definitions of renewable and non-renewable in the glossary. The "Draw Chart" on page 31 tells you how many beans to draw if you want to adapt for changes in rate of energy use. For example, if electricity use remains constant from year to year each person draws 10 beans. If you want to simulate a 4% per year increase in energy use, you go to column (marked jar 2) designated 4% increase. Be sure to look the chart over before you get to class to understand the procedure. See the accompanying fact sheet for the rate of energy consumption.

PROCEDURE:

1. Start with a ratio of 93% of a bean of one color (non-renew-able) to 7% of another color bean (renew-able) in each jar. Discuss with the class the differences between non-renewable and renewable resources, what those resources are, and how fast they think we are using them. Ask if they think the world will use more or less energy in the coming years.

2. Discuss and estimate various rates of energy use and increases in energy use over time.

3. Break into groups and have each group take turns drawing the beans at a rate chosen from the chart on the next page.

4. After drawing out the beans (representing one year's energy use) have students record the number of renewable beans and nonrenewable beans drawn for that year. Recording these numbers on a graph is very illustrative.

5. When non-renewable beans are drawn, they are considered used up; set them aside. When renewable resources are drawn, return them to the jar, thus illustrating the nature of renewable. As the drawing progress, the renewable resources become more predominant, just as they must if we are to continue using energy as we do today.

FOR DISCUSSION:

1. What kind of energy will people be using in the future? Why?

2. Why don't people use more renewable energy now?

3. Are there reasons to use more renewable now rather than wait until the non-renewable runs out?

EXTENSIONS:

1. Record the data in a data table or graph.

2. Have the students come up with various ways in which they could start using more renewable energy sources.

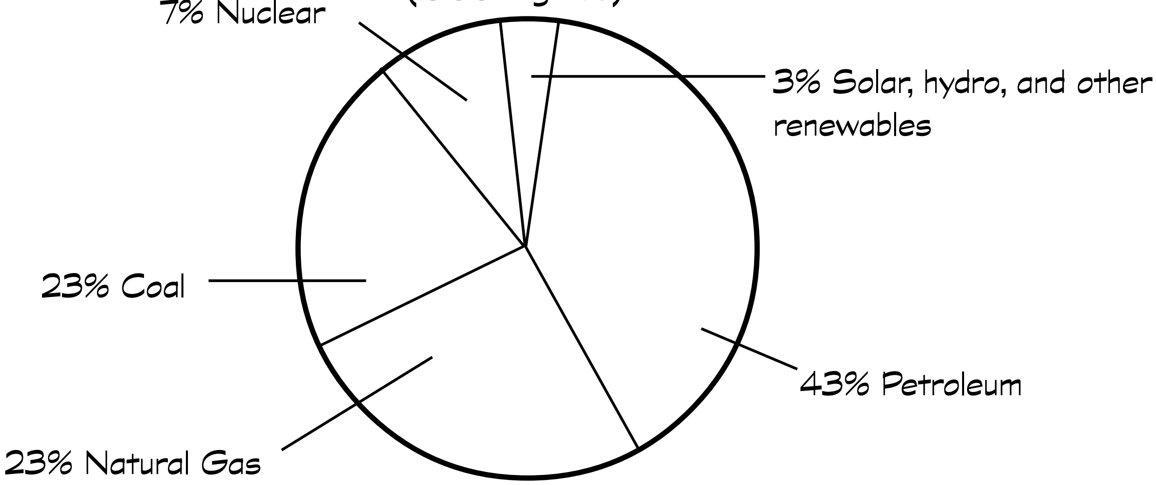
3. Calculate percentages of renewable and nonrenewable that remain after each drawing.

RENEWABLES DATA SHEET

The United States derives approximately 93% of its total energy from nonrenewables sources. About 7% of our energy comes from renewable resources. From 1986 to 1988, energy consumption has inceased by 12%.

PIE GRAPH OF ACTUAL CONSUMPTON BREAKDOWN

(1988 Figures)



(note: these figures do not include direct solar-gain heating and lighting, which is a major energy source)

DRAW CHART

This chart tells you how many beans to draw out of your jar, depending on the energy consumption rate you choose to simulate. It also shows how long the nonrenewable energy will last.

YEARS ENERGY SUPPLY WILL LAST

Consumption level	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	total
Energy use level constant, 1990																		
Use increases at 4% per year																		
Use increases by 6% per year																		
Use decreases by 4% per year																		
Energy use decrease of 6% per year																		

$\boxed{\text{BUDGET}}$

utility

(CONSERVE)

de———ferred

SCHOOL ENERGY MAP

OBJECTIVES: Students will become aware of the energy users at school.

SUMMARY: A map of the school will be made, and the energy users on campus charted and discussed.

GROUPING: 4 -6 students.

TIME: 50 minutes.

SUBJECTS: Math, geography, social studies, science, language arts.

VOCABULARY: Scale, conserve, deferred, utility, budget.

MATERIALS: Energy Users Worksheet, tape measures, graph paper.

PREPARATION AND BACKGROUND: According to the California Energy Extension Service, typical schools spend the bulk of their energy dollars on lighting (28%), heating (25%), and cooling (13%). Other energy uses are air handling (15%), hot water (5%), and "other" (14%). Students and staff can have a huge impact on these costs. We often use energy without realizing it. We tend to take lights and copy machines for granted.

In this exercise, the students will look carefully at the energy users in their school and learn about how the school's energy budget is spent.

You will need to find out what the utility rates are and how much the school spends on energy. This information is all in the school utility bills; the administration should be able to provide a copy for you. Use a bill for the same month from last year. Take the total bill (gas + electrical) and the percentages given above, and determine what your school spends on energy in the different categories. (For example: Lighting % x total utility bill = approximate amount spent on lighting for one month; repeat for heating, cooling, etc.)

When students do the mapping, it is instructive to have access to water heaters, space heaters and cafeterias. You could pre-arrange with the custodian to help out, to open doors and accompany students in areas with large machinery. This activity can be expanded to the school district or contracted to individual wings or classrooms. To shorten and simplify the activity, you can make up blank school maps, to be filled in. Otherwise it might be instructive to use graph paper and discuss drawing to scale.

Simple sketches of the school will do also. Choose the option best for your class, YOU are the expert in that department!

PROCEDURE:

1. Divide students into groups of 4-6. If you have ready-made maps, the smaller group is more appropriate. Tasks can be divided among the students. One student can translate input from others and draw the map, another can record energy users, while two students scan the area and report the things they find that are using energy.
2. Assign a portion of the school to each group. If each group works in the same scale, an entire map of the school can be assembled.
3. Students will then tour the school with the worksheet that follows. They are to carefully make note of every energy user they can find, noting where they found each. (e.g. lights, refrigerators, heaters, copy machines, etc.).
4. When the maps are done, have students list all the energy users in their area. Encourage the students to be thorough. Rather than list "lights" have them be specific (e.g. 10 fluorescent lights, and 2 regular, incandescent lights).
5. Have the class reassemble and report on what they found.
6. Next, brainstorm with students how the school might save energy. You can list the ideas on the board as they volunteer thoughts like close doors to keep heat in or out, turn off the lights next to the windows on bright days, weather strip the windows and doors, turn off lights during recess and after school, and reset thermostat to 68/80.
7. Distribute the worksheets and have students fill in the type of energy being used and propose alternatives where possible. Doing the two previous activities will help students know how to complete the worksheet.

FOR DISCUSSION:

1. Do you think other people in the school realize how much energy they use?
2. Most homes use more energy for heating and cooling; schools typically use more for lighting. Why do you think there is a difference? (Hint: lots of bodies in a classroom help keep the room warm.)
3. How can individual students help save energy at school? At home?

EXTENSIONS:

1. Repeat the exercise, only have students do their own homes this time.
2. Have students write an essay about what they think the money saved should be spent on.
3. Students could prepare a pamphlet on simple ways to save energy at school and distribute it to all classes.
4. Make posters on how to save energy at school and post them around campus.

ENERGY USERS WORKSHEET

NAMES: ______________________________________ DATE ______________

AREA MAPPED:

THINGS THAT USE ENERGY	ENERGY SOURCE	RENEWABLE? YES/NO	ALTERNATIVE OR REPLACEMENT?

in gre di ent

kilowatts

BIOGAS

ENERGY DOMINOES

OBJECTIVES: The students will get practice identifying various attributes of different energy sources.

SUMMARY: Dominoes will be used, pairing attributes to particular energy sources.

GROUPING: 1-15, as long as there is two groups.

TIME: 30 minutes.

SUBJECTS: Science, history, geography.

VOCABULARY: Ingredient, subsidized, source, kilowatts, biogas.

MATERIALS: Copies of domino playing cards. Paper and pencil for keeping score and large, flat playing surface.

PREPARATION AND BACKGROUND; This is a matching game that can require some knowledge and thought. There are both easy and hard ways to make matches. If you glue photocopies of the domino pages to cardboard, laminate them, or cover them with clear contact paper before cutting them up, they will be easier to handle and will last longer. Try copying them on several different colors of paper for a more game-like appearance.

MATCHING CARDS

There are four possibilities for matching cards,

1. An energy source may be played on itself, e.g. matching “electricity” on one card to “electricity” on another.

2. “Electricity” may also be matched to a statement that describes electricity, e.g. “a radio needs this to operate.”

3. The third type of match is between two statements that describe attributes of a common energy source, e.g. “a radio needs this to operate”, matched with “nuclear power plants produce this.”

4. Blanks may only be matched to blanks. All matches will be energy source to energy source, statement to energy source, statement to statement, or blank-to-blank.

KEEPING SCORE

Points are determined by adding the amount indicated on the two card sections matched. Players must keep a running total of the points made each turn.

ENDING GAME

There are three options for teachers to determine when the game is over:

1. No more cards can be played (when you get experienced at the game all the cards can be played virtually every time).

2. In a given time limit.

3. When a certain number of points are acquired, depending on the teacher’s discretion, winners have either played the most cards, or acquired the most points.

Stumped by some of the matching statements? All the matches are covered somewhere in this packet of activities!

PROCEDURE:

For 2 to 8 players (in teams or as individual players):

1. Shuffle the cards and deal out three to each player. The leftovers are set to the side, face down in a stack. If someone has the double "Solar" they start: if not, the next card in the stack is turned up in the playing field as a starting piece. In this case, you will need to use some random selection (either roll a die, guess a number, draw straws or flip a coin) to determine who starts. Play proceeds clock wise.

2. Players try to play all their cards each turn. If they cannot play, they may use their turn to return all their cards to the deck (stuff them in the middle somewhere) and draw three new cards. They may not play these cards until their next turn. The turn is over when they have played all the cards they can and replenished their hand from the stack.

3. See background and preparation for determining the end of the game and winners.

For 10-30 players

1. Each team should organize themselves into a playing order (alphabetically? by birth date?).

2. Shuffle the cards and deal them all out, at least one to each player, and an equal number to each team. It is O.K. if some players wind up with more than one card as long as each team has an equal number of cards.

3. The team that has the double "Solar" card goes first.

4. The first player in the sequence is the first "active" player. This player tries to play their card. If they can't play their card, they can call for a "donor conference" with their own team. The active player selects one person from their team to conference with. These two teammates can trade cards if it allows a play.

   If the donor's card cannot be played, then that team's turn is over. (You may want to allow 2 or 3 donor conferences per turn, especially when the students are just learning the cards.) You may want to define a time limit per turn. The next time this team gets a turn, the second in the playing order will become the "active" player.

5. A turn is over when a card is played, or a team cannot play at all (this is very rare).

6. See background and preparation for determining the end of the game and winners.

FOR DISCUSSION:

1. How many renewable energy sources can you name?

2. What fact(s) did you learn from the game?

3. Is there one energy source that seems to fit in a lot of places? Why?

EXTENSIONS:

1. Have students make up their own cards to either create their own game or add to this one.

2. Hold tournaments that allow students to play one-on-one.

DOMINOE PAGES 1. Photocopy, one sided 2. Cover wih clear contact paper 3. Cut along solid lines

1 NON-RENEWABLE	2 LEAST EXPENSIVE SOURCE OF ENERGY	1 GASOHOL	USES THE OCEAN'S THERMAL GRADIENT (HEAT LAYERS)	1 COAL	2 CALIFORNIA BUYS THIS FROM WASHINGTON
1 RENEWABLES	2 USED AS AN INGREDIENT IN PLANT FERTILIZER	0	2 BURNED TO PRODUCE 25% OF THE WORLD'S ELECTRICITY	1 HYDROELECTRIC	2 CAN ONLY BE USED ONCE, THEN IT'S GONE
1 GASOHOL	2 PROVIDES ENERGY FOR LIGHTS	1 NON-RENEWABLE	2 USED FOR MASS TRANSPORTATION	1 NATURAL GAS	2 MOST EXPENSIVE ENERGY FOR HEATING WATGER FOR HOMES

DOMINOE PAGES 1. Photocopy, one sided 2. Cover wih clear contact paper 3. Cut along solid lines

1 CONSERVED ENERGY	2 ENERGY FROM URANIUM 235	1 BIOGAS	2 DRIES COLTHES	1 CONSERVED ENERGY	2 MAY RUN OUT IN NEXT 100 YEARS
1 RENEWABLE	2 TELEVISION NEEDS THIS TO WORK	1 CONSERVED ENERGY	2 MUST BE MINED FROM THE GROUND	1 OIL	2 PRODUCED BY GENERATORS
1 SOLAR	2 MOST EXPENSIVE FORM OF ENERGY	1 COAL	2 BICYCLES CAN HELP CONSERVE THIS	1 NUCLEAR	2 TURNS TO ELECTRICITY IN A PHOTOVOLTAIC (P. V.) PANEL

DOMINOE PAGES 1. Photocopy, one sided 2. Cover with clear contact paper 3. Cut along solid lines

1 SOLAR	2 ENERGY FOR MOST CARS, TRUCKS AND BUSES	1 HYDROELECTRIC	2 USED TO BE PLANTS AND ANIMALS A VERY LONG TIME AGO	1 COAL	2 EMERGY FOR AIRPLANES
0	2 USED TO MAKE (PARAFIN) CANDLES	1	2 ENERGY THAT CAN BE USED AGAIN AND AGAIN	1 O.T.E.C. (ocean thermal energy conversion)	2 THE UNITED STATES IMPORTS THIS FROM MEXICO
1 NUCLEAR	2 ONE OF THE INGREDIENTS IN PLASTIC	1 WIND	2 CAUSES SMOG	1 O.T.E.C. (ocean thermal energy conversion)	2 HELPS HUMANS USE VITAMIN D

DOMINOE PAGES 1. Photocopy, one sided 2. Cover with clear contact paper 3. Cut along solid lines

1 ELECTRICITY	2 ENERGY THAT CAN BE COLLECTED FROM ANIMAL MANURE	1 NON-RENEWABLE	2 THIS CAN'T BE FOUND IN A USEABLE FORM IN NATURE	1 NON-RENEWABLE	2 THE U.S.. DEPARTMENT OF ENERGY SUPPORTS THIS
1 RENEWABLE	2 STEREOS NEED THIS TO WORK	1 ELECTRICITY	2 TURNING OFF LIGHTS IS A FORM OF THIS	1 NUCLEAR	2 SAVES MONEY
1 ELECTRICITY	2 CAN DRY CLOTHES AND HAIR FOR FREE	1 GEOTHERMAL	2 BUYING THINGS SECOND HAND IS A FORM OF THIS	1 NUCLEAR	2 LEAST EXPENSIVE WAY TO HEAT WATER AND HOME

DOMINOE PAGES 1. Photocopy, one sided 2. Cover with clear contact paper 3. Cut along solid lines

1 ELECTRICITY	0	1 RENEWABLE	0	1 COAL	0
1 NUCLEAR	0	1 BIOGAS	0	1 CONSERVED ENERGY	0
1 HYDROELECTRIC	0	0	0	1 SOLAR	0

DOMINOE PAGES 1. Photocopy, one sided 2. Cover with clear contact paper 3. Cut along solid lines

1 NATURAL GAS	2 DRESS HAIR	0	2 AN INGREDIENT IN TAR AND ASPHALT	1 COAL	2 POWERS THE WIND BY HEATING AIR AND EVAPORATING WATER
0	2 CAN CONTRIBUTE' TO GLOBAL GREENHOUSE EFFECT	1 NATURAL GAS	2 IMORTED FROM THE MIDDLE EAST	1 WIND	2 USED TO CHANGE SUNLIGHT INTO ELECTRICITY IN OUTER SPACE
0	2 AMERICANS USE MORE ENERGY THAN ANY OTHER COUNTRY IN THE WORLD	1 SOLAR	2 HIGH-MILAGE CARS SAVE THIS	1 NUCLEAR	2 PLANTS NEED THIS ENERGY TO MAKE THEIR OWN FOOD

DOMINOE PAGES 1. Photocopy, one sided 2. Cover with clear contact paper 3. Cut along solid lines

1 WIND — 0	1 COAL — 0	1 COAL — 2
1 NON-RENEWABLE — 0	0 — 2 THE MOST PLENTIFUL FOSSIL FUEL	1 SOLAR — 1 SOLAR
1 SOLAR — 2 CAN CAUSE ADID RAIN		

PENCIL AND PAPER ACTIVITIES

NAME ______________________________ DATE ______________

RENEWABLE RESOURCES

Years ago, not as many people were on the earth as there are today. People did not worry about running out of things. If some trees were cut down for wood or fuel, others would grow and take their place. If some animals were killed for food, others were born, Things that were used were replaced by new living things. For this reason, plants and animals are considered renewable resources.

Air is also a renewable. Plants and animals recycle air. Animals give off carbon dioxide that plants need.

Another renewable resource is soil. But it takes a long, long time for decaying plants and animals to become soil.

Nonrenewable resources are things, which cannot be replaced in our lifetime. Once they are used up, we will not be able to use them again. There is a limited amount of these nonrenewable resources on our planet.

Ores, from which metals are made, and minerals that come from the rocks and earth, are nonrenewable resources, Once they are mined and used up, we will not have any more. Fossil fuels like coal, oil and natural gas are nonrenewable resources also. When we have burned them up, there will be no more for future generations to use in their cars and homes.

DIRECTIONS: On the space in front of each item below, put a "R" if it is made mostly of renewable resources, Write "NR" if it is made mostly of nonrenewable resources.

paper lunch bag ______________

gasoline ______________

skateboard ______________

pencil ______________

television ______________

your desk ______________

cotton sweater ______________

cassette tape ______________

potato chips ______________

books ______________

computer ______________

car ______________

NAME ______________________ DATE __________

We know that most of the energy that we use today comes originally from the sun. Put numbers in front of the following sentences to show the order in which they happen.

FOSSIL FUEL ENERGY

____Heat and pressure over a long period of time changed decaying plants and animals into coal, oil, and natural gas.
____Light and heat from the sun provide energy for growing plants and animals.
____Fossil fuels are refined to provide energy for machinery.
____Plants and animals die and decay.
____People dig wells and drill deep into the earth to uncover fossil fuels.

HYDROELECTRIC ENERGY

____Turbines generate electricity for power.
___ Rain falls and fills rivers and streams.
____Heat from the sun evaporates water from oceans and lakes.
____Evaporated water forms rain clouds.
____Dams on rivers trap water and use water flow to turn turbines.

WIND ENERGY

____Heat from the sun warms the air.
____Windmills can be used to pump water or generate electricity.
____As warmed air rises, cold air fills in its place causing wind currents.
____Moving wind turns large blades on windmill.

PHOTOVOLTAIC ENERGY

____Energy from the sun excites the electrons in the panel.
____Moving electrons cause an electrical current.
____Sunlight hits a photovoltaic panel.
____Electricity is stored in a battery for home use.

C. NET ENERGY

This section helps teach students the second law of thermodynamics. As energy does useful work, it is changing from a higher (more concentrated) form of energy to a lower form (the least concentrated from of energy is heat). Thus, "You can't break even" or, "work + waste heat = total energy used" are ways of expressing this concept. For example, of the electrical energy that goes into a typical light bulb, 5% becomes light, the other 95% of the electrical energy is lost as heat.

"Leaf Relay" is a demonstration of energy lost with every energy transition. "Energy Pathways" and "Veggie Trails" both illustrate hidden energy inputs and how many energy transitions there are in commonly used products. "Bright Ideas" shows us how we can use technology to minimize energy losses while meeting our everyday lighting needs.

CARNIVORE

HERBIVORE

NET ENERGY NET ENERGY

trans.............fer

LEAF RELAY

OBJECTIVES: Students will learn how energy is 'lost' when transferred from one system to another.

SUMMARY: This exercise is a relay race designed to demonstrate that each time energy is transferred, some energy is lost.

GROUPING: Groups of 5.

TIME: 30 minutes - although the students will want to do it all day!

SUBJECTS: Science, P.E.

VOCABULARY: Transfer, system, herbivore, carnivore, net energy.

MATERIALS: Enough dry leaves for each group of five to have an armful, or handfuls of sand, popcorn, beans, or anything else you can find in quantity. An open, fairly flat area.

PREPARATION AND BACKGROUND: You will want to review energy in natural systems with the class before the activity. For example, the sun gives off energy that is used by plants. However, the plants do not use all the energy the sun produces. Only 2% of the sun's energy is used by plants in the process of photosynthesis. However, not all of the energy that was captured by the plant is still in the plant, since it had to use some for its own growth and reproduction. Animals then eat plants to get their energy. You can follow the energy losses through and the transfer of energy when an animal is eaten by another animal.

The same is true with energy made by humans. With each transfer, energy is lost. For example, in mining uranium, 5% of the potential energy in the uranium is used. In processing and transporting the ore, another 43% of the energy that uranium represents is used up. At the nuclear power plant, when the uranium is used to make electricity, there is a loss of 69%! Transmission of the electricity entails a loss of 15%. Once the electricity is in the house, in an incandescent (usual type) light bulb, 5% of it becomes light; the other 95% is lost as heat. In fact, if you started with 100 kilowatt hours (Kwh, a unit of energy) worth of uranium, you would wind up with a net of .7 kilowattk-hours worth of lighting for your home. The rest of the energy, 99.3%, was used for uranium mining, transporting, refining and operating the power plant and the light bulb. Help your students understand, it takes energy to get energy!

PROCEDURE:

1. Place whichever material you're using to represent energy at one end of the site in a pile. Form teams of five.

2. Have each team line up in a parallel line, with 2 to 3 feet separating each person and several yards separation each group. The teams should be lined up 100 to 200 yards away from the "energy pile." (Having the groups in a large circle surrounding the "pile" of energy allows everyone to see what is happening, but it has to be big!)

3. Quickly review food chains and assign a role to each of the students. The first person in line will be the sun; the second, a plant; the third, a herbivore; fourth, a carnivore; and fifth, a human.

4. Have each player (except the sun) mark their spots. Have the sun stand behind the "energy pile" facing their group.

5. Explain that the sun provides the energy needed in each of the food chains. Have the suns scoop up as many leaves as they can hold in their arms or as much of the substitute they can hold in their hands.

6. At the "go" signal, the suns race to the plants, who (gently) grab as much of the suns' energy as they can.

7. The plants pivot (they do not run), and the herbivores race up to grab as much energy as they can hold. The herbivores return to their spot. As soon as the herbivores return to their spot, the carnivores run up and capture the energy from the herbivores. Continue with the humans. When the humans return to their spot, have them raise the remaining energy above their heads to signal that they are through.

FOR DISCUSSION:

1. Look on the ground, what happened to the energy during transport and transfer?

2. Compare the amount held by the first and last person.

3. If there were fewer transfers, how much energy would the last person have? How could we make fewer transfers in obtaining energy in our lives?

EXTENSIONS:

1. Take out the carnivore stage and compare the amount of energy left over.

2. Introduce environmental disasters like pesticides, floods, or oil spills at one stage. Have the students immediately drop half the leaves they are carrying. This represents the damage and the lessened energy taken up or transferred. Discuss the effects of having less energy for the food chain and survival problems.

3. Assign each student one role from the uranium sequence in the background section and play the game again.

SYSTEM

ENERGY PATHWAYS

OBJECTIVES: Students will be able to analyze the energy flow and resources used in everyday products.

SUMMARY: Students will draw a "map" of the energy sources used in the materials, transporting, manufacturing, marketing, delivery, and disposing of an object.

GROUPING: 1-6 students

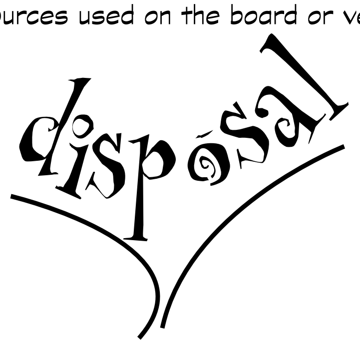
TIME: 30 minutes.

SUBJECTS: Social science, art.

VOCABULARY: Origin, ingredient and disposal.

MATERIALS: Objects for analysis are pencil, aluminum can, coat, food, and a disposable diaper. Large pieces of paper, one piece for every group of 1-6 students. Drawing instruments are crayons or colored pencils for every group of 1-6 students.

PREPARATION AND BACKGROUND: Discuss how we use many things in our everyday life, but we do not think about what goes into making them, delivering them to us, and disposing of them when we are finished using them. Choose an object with a short "history" as an example. With the whole group, discuss the raw materials used in the collection process, the machinery used in manufacturing, the transportation, marketing, delivery, and disposal of the item. Trace the energy flow and resources used on the board or verbally.



PROCEDURE:

1. Break the class into groups, up to six students in each.

2. Give each group a large piece of paper and an assortment of drawing instruments.

3. Pass out an object to every group and have them draw a map using arrows, lines, and anything else to connect the energy pathways. Don't be afraid to speculate!

4. Have students share their pathways with each other when they are finished.

FOR DISCUSSION:

1. Could you figure out all the energy that went into your object?

2. Can you think of something in the classroom that has lots and lots of energy inputs, the longest energy path? How about something with very few energy inputs, the shortest energy path?

3. Which item from question #2 costs more? Why?

EXTENSIONS:

1. Have the students make a "map" from an object at home.

2. Act out the map.

3. Try to figure out an object's pathway that you an observe firsthand: visit a farm, a processing plant, and a grocery store.

I N
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NT

VEGGIE TRAILS

OBJECTIVES: Students will gain an understanding of the many energy inputs in commercial produce.

SUMMARY: Students will compare the amounts of energy that go into an organically grown carrot and a typically produced one.

GROUPING: 4-6 students.

TIME: 1 hour.

SUBJECTS: Science, art.

VOCABULARY: Organic, pesticide, imported.

MATERIALS: Large piece of paper to draw on, crayons, pairs of produce, (e.g. two carrots, two apples, two oranges, two potatoes), one organically home (or locally) grown and one commercially grown and store-bought.

PREPARATION AND BACKGROUND: Think through the energy trail of a piece of produce. For example, a store-bought carrot: the seed is packaged by machine (petroleum); shipped by vehicle (petroleum) to fields worked by farmers (food) on tractors (petroleum) who apply (petroleum-base) fertilizer and pesticides (more petrol!). The carrots grow (using sunshine); are harvested by hand (food energy at work); transported to market by truck (petroleum); where the automatic door lets you into store (powered by electricity from a power plant). You drive to the store, to buy the carrot, at an electric cash register, etc. It is probably impossible to be comprehensive.

The trail of a home grown carrot might go like this: the seeds are harvested; the soil dug, and weeds pulled (all by hands operating on food power); and the sunshine makes the garden grow. After about 3 months the carrot can be picked, washed (food power), and eaten in the yard.

PROCEDURE:

1. Do a sample "veggie trail" with the entire class. The class can suggest the energy inputs along the way, and you can draw them on the board. Or, better yet, let them brainstorm the energy inputs and draw them on the board.

2. Break the class into small groups and distribute food items to each group and have them produce their own trail.

3. Have each group compare their results by presenting their trail to the class.

FOR DISCUSSION:

1. Where is the most energy used for the commercial produce?

2. What kind of lunch would require a lot of energy? What kind would require very little energy?

EXTENSIONS:

1. Try doing trails for imported fruits like bananas or pineapple and discuss the increased transportation costs and the labor involved.

2. Split the class in half and have each dramatize the various trails.

BRIGHT IDEAS

WATT

COMPACT FLUORESCENT

OBJECTIVES: Students will gain an understanding of the energy used to operate lights.

SUMMARY: Given information on lighting types, students will compute how much electricity and money it takes to provide lights in their homes and classrooms.

GROUPS: Divide students equally into as many groups as you have sample lighting types.

TIME: 30 minutes.

SUBJECTS: Math, science, critical thinking.

VOCABULARY: Compact fluorescent, lumen, watt, efficient.

MATERIALS: Copies of lighting survey sheet. Overhead transparency of "Anatomy of a Light Bulb." You could draw it on the board or make handouts. As many of the light bulb types listed on the survey sheet as you can find and borrow, hopefully with the boxes they came in. The rate charged for electricity in your area. Light type information guide. Use this only if you can't gain access to varied bulb types.

PREPARATION AND BACKGROUND: Collect all your materials and familiarize yourself with the diagram of a light bulb and the light type Information guide. Incandescent bulbs work by applying electricity to the filament. The filament slows the progress of the charge, thus emitting light and heat. Fluorescent bulbs apply the electricity to a contained gas; its electrons use electrical energy to jump up, then re-emit that energy as light, when they fall back towards their nuclei. Recently developed compact fluorescent bulbs have the ability to replace ordinary incandescent bulbs and operate much more efficiently. They have been improved so they give good color rendition and don't flicker or hum at all. The compact fluorescents last about nine times as long and use a fourth of the energy as incandescence!

Try to get at least one of these compact fluorescents, a rough-duty incandescent, a fluorescent tube, and a regular incandescent, each with the packaging material so the students can read the information from the real thing. (If you have trouble finding a compact fluorescent, call your local building or lighting store. Make a note of the various bulb prices.

PROCEDURE:

1. Use the picture of the light bulb to explain to students how different light bulbs work. Split the class into groups and have a couple of bulb types at several different stations. Have each group move from station to station, filling out the lighting survey sheet for each bulb type. They will complete the type, wattage, lumens per watt, and lifetime columns. Ideally, they will have an actual bulb in its packaging to collect the information from. If the bulbs are not available, you might have students go shopping and look at different bulb types at a building supply or lighting store. As a last resort, you can use the "Light Type Information Guide."

2. Next you can demonstrate for the whole class how to compute Electricity Consumption: kWh = hours of use x (wattage of bulb divided by 1000); and lifetime Cost; cost of bulb + (electric rate x kWh).

3. Have students finish the survey sheet by doing the computations with their data.

   If everyone in the U.S.A. replaced one, 100-watt bulb with a compact fluorescent, it would save as much energy as is produced by one, Chernobyl size power plant! (A. Lovins, Rocky Mountain Institute)

FOR DISCUSSION:

1. Which bulbs use the most and least energy?

2. Which bulb has the shortest lifetime? The longest?

EXTENSIONS:

1. Have students do the same computations on home lighting (don't forget the fridge light!).

2. Do a comparison of cost between existing lighting in the classroom (or home) and what might be spent with different bulbs. If you discover a potential savings, present your findings to the principal and /or board members.

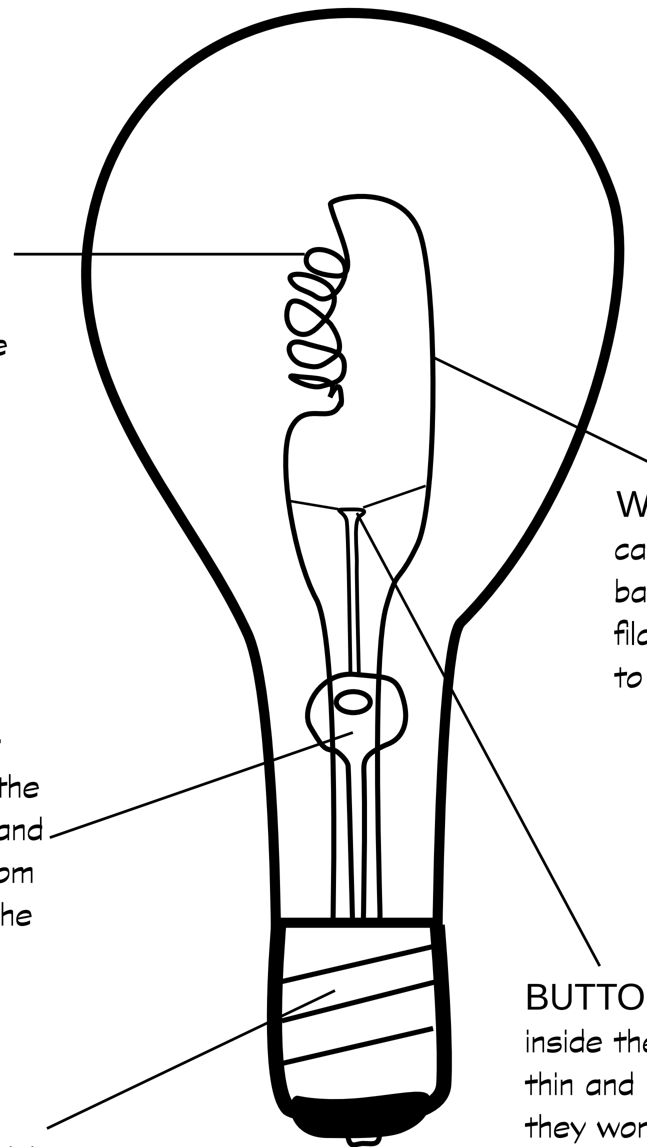
3. Compute how much energy your class can save over the school year by turning off lights next to the windows during bright times of day.

4. Compute how much energy it takes to light the classroom over the lunch hour if the lights get left on every school day. Write about how you can spend the savings if they are turned off!.

efficient

ANATOMY OF A LIGHT BULB

Light bulbs come in many shapes and sizes. Most are made of soft glass. Others are made of a harder glass to make them more durable. Gas is used to fill the bulb so that oxygen can't make the wires deteriorate as quickly. This is a drawing of a typical incandescent light bulb.



FILAMENT:
The filament is where electricity is changed into heat and light. The filament is made of wire that is very tiny and coiled very tightly.

WIRES: The wires carry electricity from the base of the bulb to the filament and then back to the base.

FUSE: If there is ever too much electricity in the bulb, the fuse will melt and keep that electricity from damaging the lamp or the household circuit.

BUTTON: The wires inside the bulb are very thin and need support so they won't shake around too much or fall into each other. The button supplies this support.

BASE: Electricity comes through the lamp and is transferred to the bulb by the base.

LIGHT TYPE INFORMATION GUIDE

BULB	WATTAGE	WATTAGE	WATTAGE
COMPACT FLOURESCENT	7W - 32w	65	65
COOL WHITE FLOURESCENT (4')	40w	46	46
WARM WHITE FLOURESCENT (4')	40w	46	46
INCANDESCENT	20w -1 500w	18	18
ROUGH DUTY INCANDESCENT	20w - 1500w	10	10
HIGH PRESSURE SODIUM	70w - 1000	104	104
LOW PRESSURE SODIUM	18w - 180w	100	100
MERCURY VAPOR	50w - 1000w	33	33

LIGHTING SURVEY SHEET

Bulb type	Wattage	Avarage Lumens per watt	Avarage Lifetime i in hours	Electric Consumption in Kwh = hours x $\frac{\text{Wattage}}{1000}$	Lifetime Cost = cost of bulb + electric rate x Kwh

PENCIL AND PAPER ACTIVITIES

NAME____________________ DATE______________

Today, many people have food freezers in their homes. They are used to store foods at low temperature to prevent the food from spoiling.

There are two types of food freezers. One is called "frost-less" or "frost-free," which means that it automatically defrosts (removes the frost and ice). There is a small heater in the freezer that melts the ice. This heater requires more electrical energy than the other kind of freezer. The other is called a "manual defrost," which means you need to turn it off and remove the frost and ice by hand. Use the chart below to find out how much it costs for electricity to operate both kinds of freezers.

One kilowatt (kWh) cost $.10.
A frost-less freezer (15 cu. Ft.) uses 5kwt per day.
A manual defrost freezer (15 cu. Ft.) uses 3kwt per day.

How much does it cost to operate a FROST-LESS freezer for:

One day__________________
One month (30) days __________________
One year (365 days) ________________________

How much does it cost to operate a MANUAL DEFROST freezer for:

One day ______________________
One month (30) days _____________________
One year (365 days) _____________________

Which one costs less to operate? ___________________

How much less:
Per day ____________
Per month __________
Per year ___________

NAME________________________ DATE________________

Leaky faucets can waste a lot of water. Energy is used to transport water and to make it clean enough to drink, so wasting water is also wasting energy. To find out if you have a leak, turn everything off carefully so that no water is being used anywhere in the house. Then go check the water meter: if it does not change over 15 minutes, then you know there are no leaks. If it does change, start looking for the leaks.

DIRECTIONS: Find out how much water can by wasted by changing pints to quarts and quarts to gallons.

> Remember: 2 pints = 1 quart
> 4 quarts = 1 gallon
> 8 pints = ? gallons

A slow-leaking faucet can waste up to 5 pints of water in one hour.

1. How many pints of water are wasted in four hours?

2. How many quarts are wasted in eight hours?

3. How many gallons of water are wasted in 24 hours (one day)?

4. How many gallons of water are wasted in one month (30 days)?

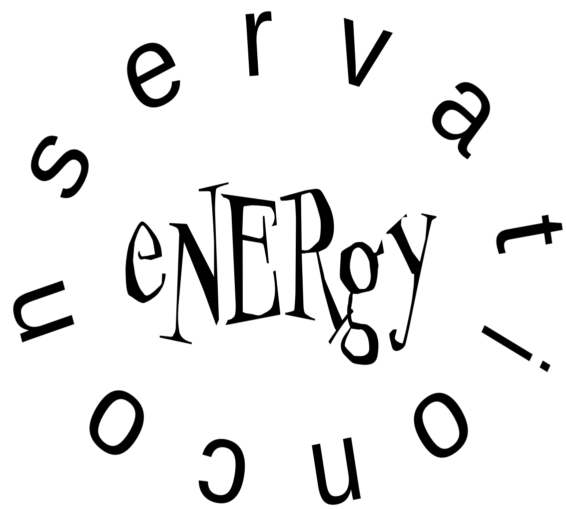
5. How does wasting water also waste energy?

6. What are some good ways to save water?

D. ENERGY CONSERVATION

Conservation is the least expensive "source" of energy available today. Every bit of electricity that is not used to light a room that one is in, could be used to operate a computer. Power companies have found that mining this kind of wasted energy is often more profitable than generatinlg more energy. The amount of energy that a utility can get its users to save can be sold to other users; incentive programs for saving energy turn out to be profitable to the utility companies. Because of peak-use problems, the utility must have enough energy available to satisfy the needs of all users at peak hours. This often means building an entire power plant (or more) just to cover the demand over a 2-4 hour portion of the day. When everyone conserves energy, the utility can meet peak demand without a new plant and the building and maintenance expenses that it would incur. Finding a way to do-more-with-less benefits everyone.

The activities "Trip Tix" and "Meter Reading" will help the student understand some of the common ways that they use energy and begin to give them an idea of volume of energy used. The "Solar Cooker" and "Insulation" activities show ways to use less energy by using renewable energy. "Energy Patrol" really lets the students see how they can make a difference. This is very important: we must teach skills for dealing with problems and not merely raise awareness. If we teach students about global warming, resource depletion, and air pollution, then we must also teach them about energy conservation, renewables, and mass transit; otherwise, we paint a gloomy hopeless picture that no one will face.


eNERgy
conservation

TRIP TIX

OBJECTIVES: Students will become aware of their daily energy use and the effect conservation would have on that use.

SUMMARY: Students will use tickets to “pay” for trips during the school day, thus learning conservation strategies.

GROUPING: Entire class.

TIME: 30 to 45 minutes preparation, ongoing for one day or several weeks!

SUBJECTS: Problem-solving and classroom management.

VOCABULARY: Conservation.

MATERIALS: 50 energy trip tickets per student.

PREPARATION AND BACKGROUND; You will need to copy off the ticket page and either cut them up or have students cut them. Some teachers find that if you limit students to only a few per day, it helps students learn the lesson better. Have the students place their name on each of the tickets. Play the game, for as long as you feel is necessary for conservation strategies to evolve. The time can be shortened or lengthened by providing more or less energy trip tickets. Some teachers have told me that this project helps to control the wandering students in their class, and they use it intermittently as needed throughout the school year.

PROCEDURE:

1. Have the students brainstorm the places they go to during an average day at school. Some possible places are pencil sharpener, drinking fountain, restroom, lunch, recess, music p.e., library. After the list is generated, have the students go to all these places to use energy. Discuss the various sources and types of energy used. Tell your students they are going to learn how much energy they use. Hand out tickets and have students initial their own 50 tickets.

2. Each time the student takes a trip, it costs one energy ticket. Place a large envelope on or near the door and have students put the tickets there for collection. If a student runs out of tickets, they cannot take any trips. (An exception-or loan-may be given for the restroom.)

3. Keep a record of how many tickets the students have used each day and take time to discuss:

   Which students are wasting energy?

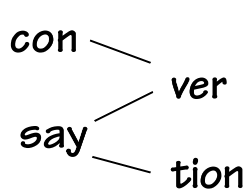
   Which students are conserving energy?

   How are they doing it?

   What are some ways they could save energy

   -in the classroom?

   -in the whole school?



   Stress the idea that in one trip you can accomplish several things. At recess, I can get a drink, sharpen my pencil, and go to the restroom for one ticket. Otherwise, it could cost me four tickets if I did them one at a time.)

4. At some point before ending the activity, discuss the idea of running out of energy tickets. There are no more energy tickets left for the rest of the week. How will this effect the class, and what can we do about it now?

FOR DISCUSSION:

1. How did conservation effect the quality of classroom life?

2. How did the "energy shortage" affect energy use?

3. It takes energy to supply the things people use to make their lives easier, more comfortable, or enjoyable. How might energy conservation or energy shortage impact their everyday life?

4. How might energy use decisions affect the standard of living and quality of life?

EXTENSIONS:

1. Have the students write a story about "The Day The Energy Ran Out."

2. Discuss how the students use and could conserve energy at home. Have them write up an official contract, stating the ways they will conserve, and have them sign it.

3. Have each ticket marked as to what it was used for. At the end of the activity or each day, chart use on a classroom map and discuss some conservation possibilities.

TRIP TIX TICKETS

ENERGY TICKET GOOD FOR ONE TRIP NAME	ENERGY TICKET GOOD FOR ONE TRIP NAME	ENERGY TICKET GOOD FOR ONE TRIP NAME	ENERGY TICKET GOOD FOR ONE TRIP NAME	ENERGY TICKET GOOD FOR ONE TRIP NAME	ENERGY TICKET GOOD FOR ONE TRIP NAME	ENERGY TICKET GOOD FOR ONE TRIP NAME
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METER READING

OBJECTIVES: Students will learn to read utility meters and compute energy use.

SUMMARY: After learning to read gas and electrical meters, students will then proceed to monitor the energy used in their homes and keep a daily record. At school, the information will be compiled and discussed.

GROUPING: Groups of four or five individuals.

TIME: 30 to 50 minutes for initial lessons; then 20 minutes per day over one week or more.

SUBJECTS: Math and science.

MATERIALS: Meter reading practice sheet and home meter worksheet.

PREPARATION AND BACKGROUND: Make copies of the worksheets: one of each for each student. Meter reading can be kind of tricky. It helps to remember these rules:

- The dials are like watch faces, BUT every other dial moves counter-clockwise.
- Always read the faces from left to right.
- If the pointer is between two numbers, always record the number it has just passed (this is the smaller number, except when passing from 9 to 0: the 0 represents a 10 in this case).
- If the pointer seems to be pointing directly at the number, refer to the dial on the right. If the hand on the dial to the right has recently passed zero, then you should put down the number that the other hand seems to be pointing at. If the dial on the right is short of zero, put down the next lower number. (Meters needles are not always positioned precisely; they may appear to have reached a number before it is appropriate.)

Use the practice meter reading sheet and look at the examples awhile. These rules actually make sense when you see that each of the dial faces represent a ones, tens, hundreds, thousands and ten thousands column.

Note: Some meters are marked with a x10 or x20. These meter readings should be multiplied by 10 and 20 respectively.

PROCEDURE:

1. Go over some energy bills from home so students understand how to read them.

2. Teach the class to read meters (review the preparation and background section if necessary).

3. Next assign them to groups of 4 or 5 to practice using the sample worksheet. They can do the examples "round robin" style; one student or group does a problem then the next student or group checks it and does the next example. This continues through the groups.

4. When they seem to be getting the drift of it, distribute the home energy-use sheets. Explain to students how they will be checking their gas and electricity meters at home daily. They will compute a total for both cubic feet of gas and kilowatt-hours. If possible, it would be interesting to have one student do the school meters.

5. Each day in class, you can take a few minutes to see if anyone has had any problems. At the end of the week, everyone can see how much electricity and gas their family has used.

ANSWERS FOR WORKSHEET:

1. 18192	4. 9486
2. 62579	5. 2620
3. 62606	6. 8702

FOR DISCUSSION:

1. Does your family spend more money on gas or electricity?

2. Can you think of five ways to use less gas and electricity?

3. Where does your gas and electricity come from?
4. How much gas and electricity did the families of the whole class use in a week? A year?

5. How much gas and electricity did the families of the whole school use?

EXTENSIONS:

1. You can do a spelling bee activity with meter reading: set up a few dials on the board and change the arrows for each player.

2. Lengthy discussions can develop around the energy use in different homes. A before and after study can be done, incorporating energy saving techniques in the household and computing savings afterwards. Students can compare the type of appliances they have to the amount of energy they use.

3. Week long samples can be done at different times of year and compared. This illustrates where energy use is highest, usually when heating or air conditioning are used.

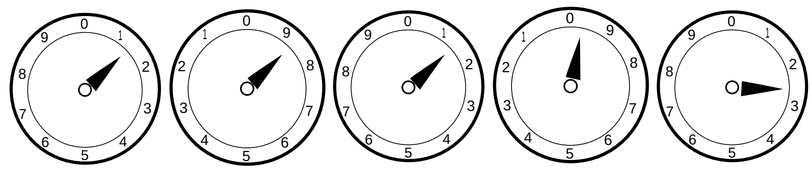
4. Chart or graph a year's worth of your own energy bills and present them to your class. Discuss with students the possible reasons for the fluctuations.

METER READING WORKSHEET

Read the following meters and write your answer in the space below each dial face.

ELECTRIC METERS

1



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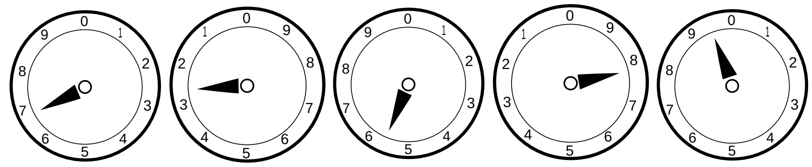

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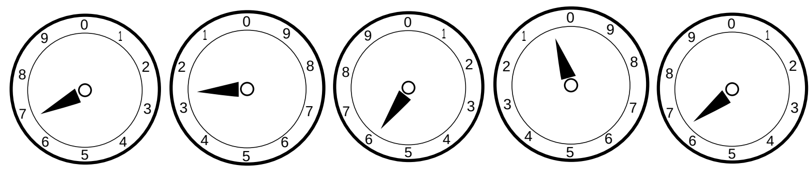
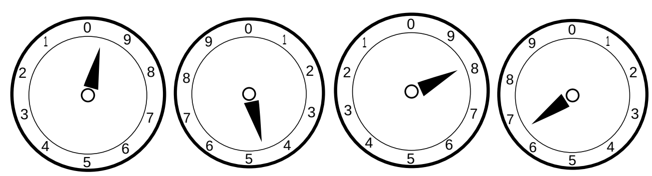


GAS METERS

4



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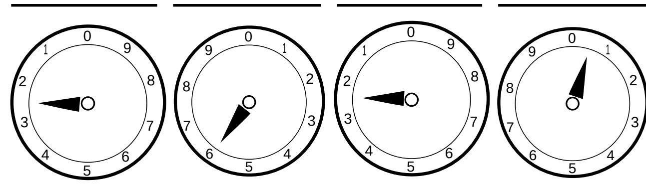

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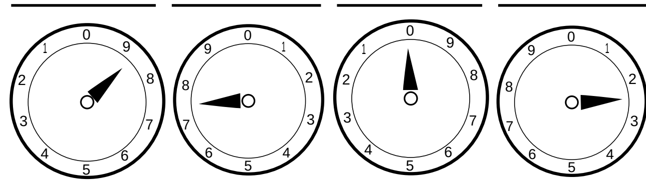
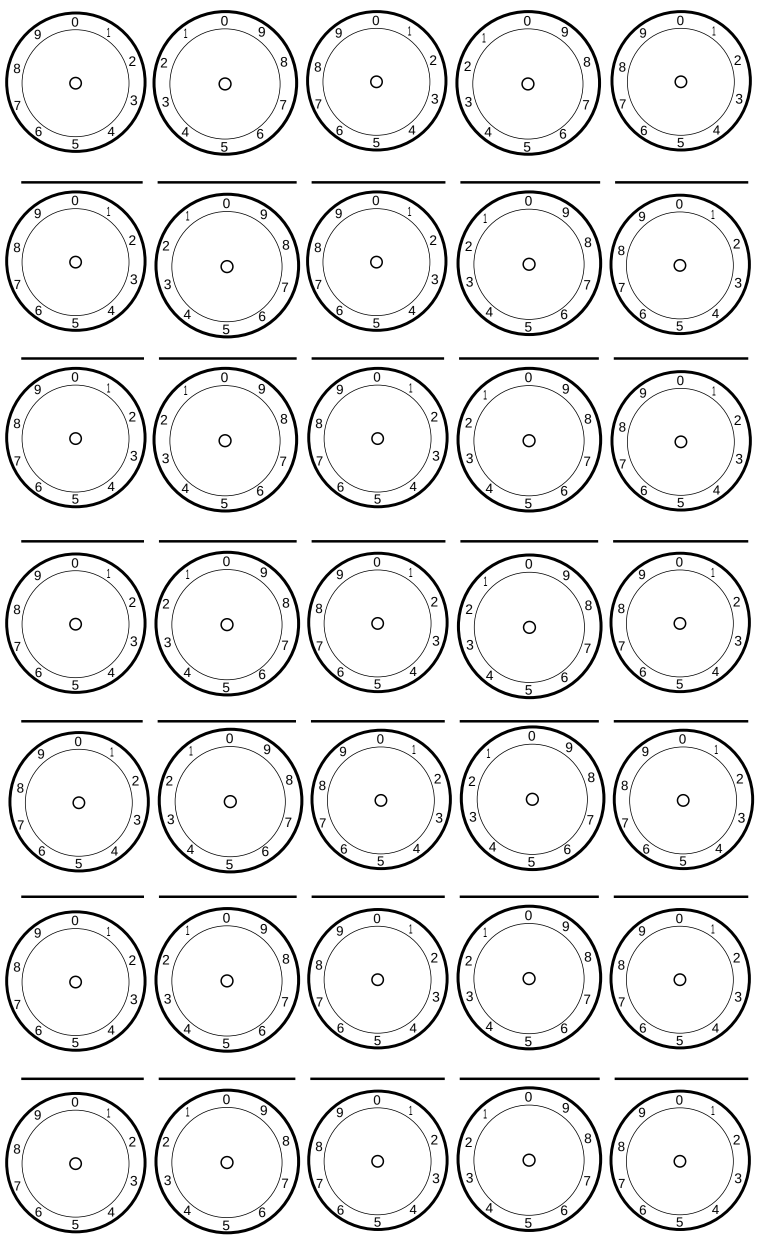


METER READING WORKSHEET

1. Draw the positions of the hands of the meter on the dials each day at the same time.
2. Write the number in the space below each dial and on the line at the right.
3. Subtract the readings on day one from day two. Repeat each day for seven days, always subtract the previous day's reading from the present day's reading.

________ Electric Meter ________ Natural Gas Meter



Meter reading Day 1 ________

Reading Day 2 ________
Reading Day 1 ________
Energy Used ________

Reading Day 3 ________
Reading Day 2 ________
Energy Used ________

Reading Day 4 ________
Reading Day 3 ________
Energy Used ________

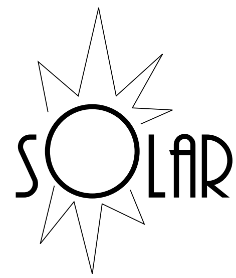
Reading Day 5 ________
Reading Day 4 ________
Energy Used ________

Reading Day 6 ________
Reading Day 5 ________
Energy Used ________

Reading Day 7 ________
Reading Day 6 ________
Energy Used ________

SOLAR COOKER

OBJECTIVES: Students will learn how the sun's energy is reflected, trapped and used for heating.



SUMMARY: Students will learn basic solar heating principles by building and using a solar cooker.

GROUPING: Individuals or pairs.

TIME: 1-hour construction, various cooking times.

SUBJECTS: History, social sciences, health.

VOCABULARY: Reflection, solar, construction, parabola.

MATERIALS: 1 long narrow cardboard box per group, aluminum foil, poster board, parabolic curve template (following page), tape, utility knife, piece of paper per group, white glue, and one skewer (shish kabob skewer or sterilized coat hanger) pre group.

PREPARATION AND BACKGROUND: There are several types of solar cookers. The most common type is a solar oven, but its construction involves detailed work. The solar cooking spear is of simple construction, that can be completed in the morning in time for lunch. A variety of vegetables and meat can be used for lunch. Choose the longest boxes possible for the cooker so that the most heat collection is possible. Although cloudy days can be used, sunny bright days work the best. Discuss how the students and different cultures around the world cook their meals. Trace different ways of cooking meals back to the original energy source. Introduce using the sun directly to cook a meal.

PROCEDURE:

1. Have each group collect the materials needed.

2. If the box has a lid, remove it.

3. Using a demonstration model, or on the chalk board, find the center point on one of the ends of the box within 5 to 10 inches of the top of the box.

4. Trace the template on the long sides of the box going through the center point.

5. Cut out the curve with the utility knife. Stress the importance of being exact.

6. Measure and cut a piece of poster board that will fit flush against the opening to the box.

7. Attach the poster board with tape beginning at the center and working toward the edge.

8. Cover the curve with white glue and apply aluminum foil shiny side out. Start in the middle and smooth toward the edges. Try not to wrinkle or fold the foil; you want it as smooth as possible.

9. Cut out two scraps of poster board or card board as supports for the skewer. Tape each support to the center of the curve.

10. Using the sun or a projector light, test the focal point. (There should be a bright spot on the supports where light is concentrated.) Mark the spot and make a hole for the skewer.

11. Spear the desired food to be cooked. Put skewer into place.

12. Set in direct sunlight and enjoy!

FOR DISCUSSION:

1. How much energy did it take to cook your meal? Compare it with your dinner last night.

2. Do you need to have direct sun? Why?

3. Discuss what else can be cooked in the sun.

EXTENSIONS:

1. Make sun tea to go along with the sun-cooked meal.

2. Compare the energy that goes into a TV dinner (don't forget the energy in the packaging and a solar-cooked meal

3. Have a contest designing different kinds of solar cookers.

parabola construction

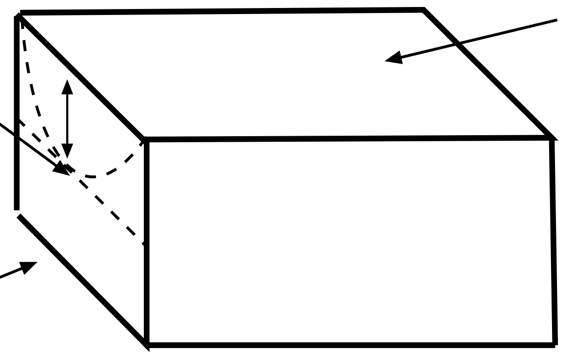
SOLAR COOKER INSTRUCTIONS

1. Remove lid

2. Find the center point on the end of the box.

3. Trace the template (included) on the box. The point of the template should be on the center point.

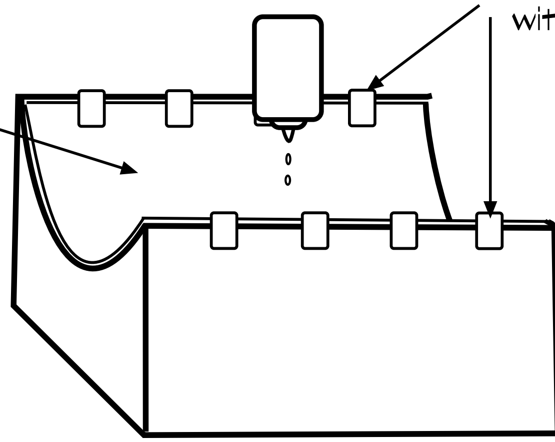
4. Do the same on the other end.



5. Cut out the box above the template lines. (Be exact)

6. Measure and cut poster board to fit here.

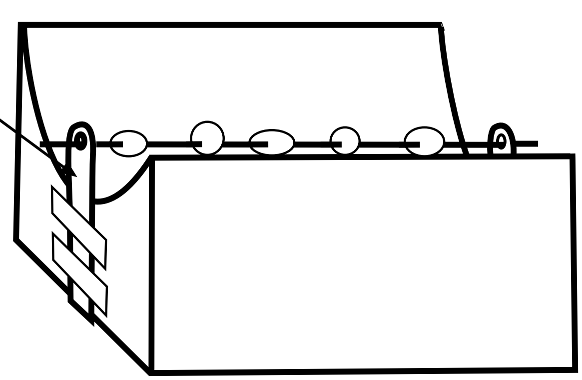
7. Attach poster board to box with tape.

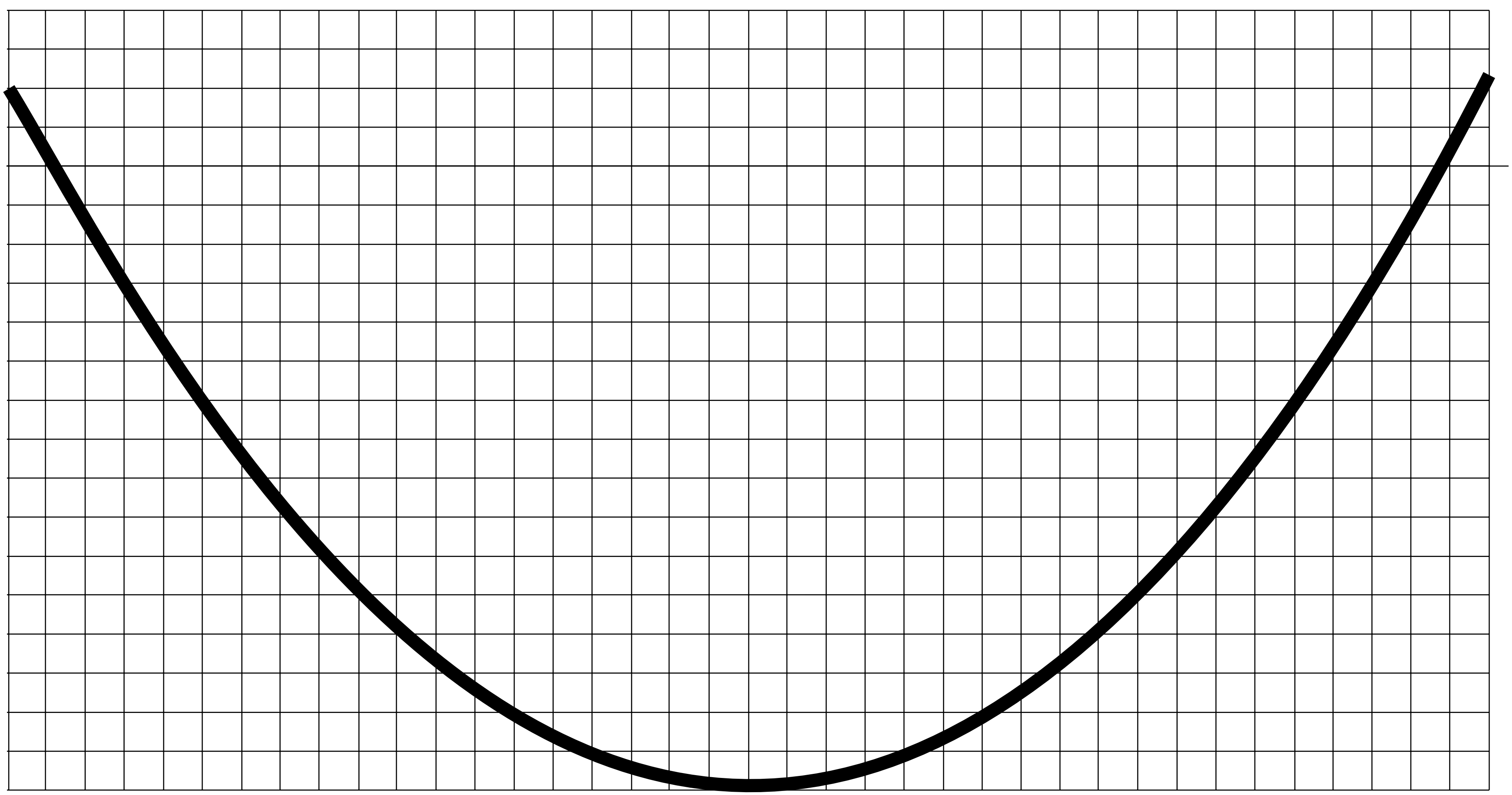


8. Cover poster board with glue. Attach aluminum foil starting in the middle and working toward the edges.

9. Attach cardboard supports for the skewer.

10. Place the box in the sun. Look for the spot where the sun shines on the cardboard support. This is the height you want the skewer.





TEMPLATE FOR SOLAR BOX COOKER

This is the graph of the equation $y=ax^2$.

The shape is call a parabola and has the ability to focus light.

This parabola is a wide open one, so it can collect as much sunlight as possible.

You can find the focus emperically as described in the directions, or you can use the equation, $f=1/4x$

Cut out the shape carefully and trace it on the side of your box. Cut out the shape of the parabola from both ends of our box.

INSULATION

OBJECTIVES: Students will determine how insulation can affect heat loss and heat gain.

SUMMARY: Students will monitor the different rates of temperature change in insulated containers.

GROUPING: 4 to 5 students.

TIME: 40 minutes.

VOCABULARY: Insulation, relative change.

MATERIALS: Hot water and ice water, a set for each group; three boxes and three cans (or other watertight containers that fit into the box with some space for insulation); three types of insulation (e.g. sand, paper, quilting, air, sawdust, socks, construction insulation materials); three thermometers per group and copies of the data chart for each student.

PREPARATION AND BACKGROUND: Collect the materials and make copies of the date sheet. Make sure you have access to HOT water and ice-cold water (do not use the ice itself). More extreme starting temperatures provide more dramatic results. Have half of the groups experiment with ice-cold water and half use hot water. Be sure the containers are insulated on the bottom, as this will prevent some conductive heat loss.

RELATIVE CHANGE

PROCEDURE:

1. Break the class into groups.
2. Have each group collect their materials and assemble them. Make sure they are using three different insulation materials. Each group should predict which container would hold the temperature best.
3. When everyone is ready, you can pour the water for them to be sure the insulation stays dry.
4. Have the student's take a reading two minutes after the water is added and again once every five minutes for one half hour.
5. Have students do a lab write-up with graphs, results and theories.

FOR DISCUSSION:

1. What materials held the temperature best?
2. Which material would be best for keeping your house warm? Cool?
3. What are some commonly used objects that use insulating materials? (Down jacket, plastic thermos.)

EXTENSION:

1. Have students design containers that will hold in heat and give off heat. Once they are constructed, there could be temperature change races. Theories on heat transfer can be developed.
2. Get extra thermometers and measure the temperature at the top and bottom of the containers to illustrate thermal stratification and the relative rates of loss.
3. Set up a control container and monitor temperature changes with no insulation.

FIND THE BEST INSULATOR

NAMES:

________ ICE WATER ________ HOT WATER

INSULATION MATERIALS USED	ELAPSED TIME IN MINUTES						TEMPERATURE CHANGE
	5	10	15	20	25	30	

1. What was the best insulator?

2. What was the worst insulator?

3. How does insulation save energy at school and at home?

ENERGY PATROL

OBJECTIVES: Students, involved directly and indirectly, will take responsibility for their actions and teach others about conservation.

SUMMARY: Students will inspect the school for wasted energy, record data, and give feedback to peers.

GROUPING: Pairs.

TIME: Continuous throughout the school year. Approximately 5 minutes per inspection at recess and lunch and 10 minutes after school.

MATERIALS: Badges, armbands, vests, or some other distinguishing article and one checklist per month.

PREPARATION & BACKGROUND: Throughout the school, the energy patrol is responsible for finding and stopping energy leaks. Energy leaks include lights left on in an empty room, doors left open with the air conditioner or heater running, thermostats set above 65°Fahrenheit, and aluminum cans thrown away. Review with the class various ways energy is wasted in the classroom. You can brainstorm ideas and list them on the chalkboard. (See check list for ideas.)

PROCEDURE:

1. Introduce the idea of "patrolling" the school for leaks. Stress the professional role of a patrol person and the responsibility associated with entering an empty room.

2. Review the checklists with the class. Note that the recess and lunch checklist deals only with lights left on, and the after school checklist deals with more items.

3. Take the entire class on a patrol having each student fill out a checklist.

4. Review the energy leaks found on the introductory patrol and list ways to "plug" the leaks. Try to keep the focus on solutions the students could do immediately. For example, if the lights are left on, the students could turn them off and leave a small preprinted note above the light switch.

5. Ask for or assign patrols for the next week or month. CAUTION: Be careful whom you pair together! Remember they will be working unsupervised! The same pair could inspect at recess, lunch and after school for a day.

(Based on an activity by Cupertino Union School District!)

ENERGY PATROL CHECKLIST

Month ______________ Room Number __________

DATE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Area in use																															
Lights on																															
Door open																															
Thermostat set higher than 65°																															
Windows open with heater or A.C. on																															
Leaking Faucet																															
Aluminium cans in trash																															
Recyclable paper in trash																															
Left note for teacher & class																															

RECESS__________

LUNCH __________

AFTER SCHOOL ______________

Inspector's Names ______________________________

____

PENCIL AND PAPER ACTIVITIES

NAME______________________ DATE________________

Fifty percent of all energy used in California goes for transportation. This is 1/2 of all our energy needs.

DIRECTIONS: Reduce the fractions to their lowest terms. Use your answers to solve the riddle.

6/8=____________ =N	4/24= ____________=R	2/6= ____________=H
2/18= ___________ =Y	4/6= _____________=A	1/15= ___________ =P
3/6= ____________=O	12/20=____________=T	4/10= ___________=G
2/8=____________ =I	10/100=___________=U	6/6=____________ =B

What is a history of cars called?

____	____
2/3	3/4

___	___	___	___	___	___	___	___	___	___	___	___	___
2/3	1/10	3/5	1/2	1	1/4	1/2	2/5	1/6	2/3	1/15	1/13	1/19

Speeds of 35 to 40 MPH save the most gasoline.

Extra weight and air conditioning use more gasoline.

NAME ______________________ DATE ______________________

BATH OR SHOWER?

You will need a bathtub and a yardstick to do this experiment. The experiment will show that we would save a lot of energy and water if people took showers instead of baths.

Begin the experiment by taking a bath. Fill up your bathtub with water as you usually do. But before you go in, measure the depth of the water with your yardstick. Write down your measurement.

The next day (or whenever you need it) take a shower. Before you turn the water on, close the drain. This will keep your shower water in the tub. After you have finished your shower, get out and measure the depth of the water before draining the tub. Write down the measurement. Now compare the depth of water that you used for bathing in the tub and in a shower.

Most people use a lot less water when they shower. This means that they have saved on water and on the energy that heats water.

1. What materials did you use for this experiment? ______________________

2. What are the three main steps for this experiment? ______________________

3. How does saving water also help save energy? ______________________

4. What is another way to save water and energy? ______________________

5. Why is it important to save water and energy? ______________________

E. RECYCLING

These activities are designed to help students realize that they can actively participate in energy conservation through recycling. "Litter analysis" is a close-to-home demonstration of recycling and how to reduce waste. "Garbage" is more of a community perspective on waste management. "New Old Paper" is a hands on activity where the students get a chance to actually recycle some old classroom paper themselves.

We highly recommend contacting your local community — recycling center about starting a school-site recycling center. Often these people can provide containers for gathered materials, handle all the pick-up, and even supply educational materials to boot! This project can teach social skills, math, science, vocational skills; provides students with an opportunity for success that might not be as readily available in the classroom.

LITTER ANALYSIS

(CONSERVE)

OBJECTIVES: Students will learn that much of what is called garbage is recyclable, saving money and energy.

SUMMARY: The class will investigate the types of things that wind up in their trash.

GROUPING: Entire class.

TIME: 10 to 40 minutes.

SUBJECTS: Social science and critical thinking.

VOCABULARY: Recycle and conserve.

MATERIALS: A can of trash.

PREPARATION AND BACKGROUND: Looking at the contents of the classroom trash container can illustrate the waste disposal problems of the world. We are producing more and more garbage and quickly running out of places to put it! Fortunately, we have alternatives. On average, a landfill contains 46% paper, 22% compostable biomass, 10% glass, and 8% metals. The garbage that is not recyclable is usually around 20%. The best way to prevent our landfills from overflowing is to use less. Short of that strategy is recycling, what we do use. Recycling paper saves 50% of the energy it takes to make paper from trees. Recycling aluminum cans saves 95% of the energy it would take to mine the metal and start from scratch. Recycling not only saves energy, but also conserves resources and creates less pollution. So, for all you recyclers (and future recyclers), HURRAH!

There are lots of ways to use less: use returnable bottles, reuse your grocery bags, use a lunch pail; buy food in bulk, buy things secondhand, use old paper for scratch work. You can have the class try to come up with the longest list of ways to conserve.

Before you do the activity, you may want to "spike" your class room trash can to be sure common recyclables like glass, paper, and aluminum are represented.

recycle

PROCEDURE:

1. Hand a piece of used paper or other trash to a student and ask them to throw it away. Ask the class to define where away is. Discuss that away really isn't — it's just out of sight. This will launch the activity. Review what becomes of the things we throw "away" everyday.
2. Spread some newspaper on the floor or a big table and dump the contents of the class trash can on to it.
3. Have the students break into groups and categorize the contents.
4. Have groups share their categorizations.
5. Talk about the problems our country is having with trash disposal and how recycling can help.

FOR DISCUSSUON:

1. What things in this trashcan can we recycle?
2. Why don't people recycle more?
3. Do you, or people you know, recycle?
4. How does recycling help save energy and resources?

EXTENSIONS:

1. Call the local Community Recycling Center and have them help you set up a school recycling center.
2. Have students repeat the activity at home with supervision.
3. Have students analyze the trash of different classes and reward the least wasteful class.
4. Have students brainstorm and list ways to reduce trash at school and at home.
5. Analyze the lunch yard trash and send a summary of the items wasted to parents. They would then know what not to put in school lunches.
6. Have the whole class make cloth reusable lunch bags.

NEW OLD PAPER

OBJECTIVES: Students will learn recycling and conservation techniques by reusing paper from used paper.

SUMMARY: Students will make new paper from used paper.

GROUPING: Small groups of 3-4, or if materials are limited, the entire class.

TIME: Day one - 30 minutes; Day two - 50 minutes.

SUBJECTS: Science, art.

VOCABULARY: Fibers, pulp, recycle, conserve.

MATERIALS: Old newspaper, scraps of school paper, or used brown bags. 3-5 two gallon buckets or pans per group. An eggbeater per group, a rolling pin per group, a screen per group or take turns using one, and a magnifying glass.

PREPARATION AND BACKGROUND: Talk with students, encouraging them to provide the details, about where paper comes from, tracing the production process. Discuss the cutting down of trees, transport to the lumber mill, transport to the pulp mill, transport to the paper mill, and then to the people who use it. Discuss how many trees and how much energy this process takes.

Brainstorm ways the students can conserve trees and energy. Discuss how using the front and back of every sheet of paper saves resources and how making new paper from used paper saves even more. Making new paper from old paper uses half the amount of energy as making new paper from trees. Besides using less energy, recycled paper saves trees that play a vital role in cleaning up industrial pollution by absorbing carbon from the atmosphere — not to mention all the animals' homes provided by trees and how nice they are to look at! Collect your raw materials by having the students bring in old newspapers and scrap paper from home. You can also have them gather paper around the classroom that is ready to be recycled. If you want to make colored paper, you can add poster paints to the fiber pulp.

fibers

recycle

PROCEDURE:

DAY ONE

1. Separate the different kinds of paper and pile them together (i.e. newspaper, white paper, brown paper bags, etc.)
2. Spread out some newspaper to work on. Shred the old newspapers, scraps or paper bags.
3. Fill the buckets or pans with two parts water to one part paper.
4. Let the mixture sit overnight. The fibers will be soft and ready to pulp the next morning.

DAY TWO

1. Use the beater to pulp the fibers. Pulp the mixture until it's like mush. (Pulping breaks down the fibers into a form that can be bonded together again to form recycled paper.) If you are using newspaper, you can "de-ink" pulp through a rinsing process. Simply exchange the water with clean water three or four times until the water stays reasonably clear. This process is the same one paper mills use, except they use chemicals to bleach fibers white.
2. Look at the pulp with a magnifying glass.
3. Discuss the origin of the loose wood fibers.
4. Have the students press the pulp between their fingers. Do the wood fibers bond together again? Discuss how and why this happens. (The fibers adhere to each other by interlocking little fibers.)
5. Working over a sink or outside, place a handful of pulp flat with a rolling pin.
6. Remove the paper from the screen and lay flat to dry.

FOR DISCUSSION

1. Review the origins of paper and discuss logging practices.
2. Where does paper go if we don't reuse it?
3. What happens if we all take our paper to the recycling center, but no one buys recycled paper products?
4. Talk about some of the problems of cutting down too many trees (e.g. increase global warming, loss of habitat, loss of scenic beauty).

EXTENSIONS:

1. Add leaves or other objects on the screen to make imprints on the paper.
2. Use the paper for an art or language arts assignment.
3. Make paper-planting cups and grow plants in the classroom for home or school grounds. Just shape the wet paper about 1/4" to 1/2" thick inside the desired container and let dry about three days. Discuss that the container is biodegradable and so can be planted in the ground with the plant (see Solar Collector activity).
4. Visit a lumber mill and/or paper mill or have a representative visit your classroom.

(CONSERVE)

pulp

GARBAGE, GARBAGE, GARBAGE

OBJECTIVES: To develop a conservation and recycling ethic by examining what garbage is and what happens to it.

SUMMARY: Students choose and create strategies for dealing with their daily garbage.

GROUPING: Small groups of 3 to 4 students.

TIME: 45 minutes.

SUBJECTS: Social studies, science, language arts.

VOCABULARY: Landfill, incineration, garbage.

MATERIALS: 300 raisins (separate into piles of 20), one recording sheet per group and data sheet.

PREPARATION AND BACKGROUND: Americans often take waste disposal for granted. When we throw things away, energy is wasted instead of being recycled. For example, it takes energy to make every container that we use. In fact, the amount of energy that went into making a 12oz. Aluminum soda can is equivalent to approximately 4 oz. of gasoline. Usually more energy is invested in a can than in the soda it holds. Therefore, if you recycle that container, that much energy is saved — not to mention landfill space, resources, and pollution from production.

This activity addresses the question: What would happen if garbage trucks stopped coming and we had to deal with our garbage every day?

Explain the rules: No one eats raisins until the activity is over. The object is to conserve as many raisins as possible. The groups have to agree with each other on what to do with their garbage. Different strategies in dealing with the garbage have different costs (different amounts of raisins) depending on the amount of energy they use.

Divide into groups and have each group pick up 20 raisins and a record sheet.

PROCEDURE:

1. Set the following scene: A huge storm has occured. Roads have been damaged and electric lines were knocked out, so the power is off, and gas pumps are closed. The weather has cleared somewhat, but it will be a month before everything is back to normal. Garbage service has been suspended, and each group of students must decide what to do with their waste.

2. Brainstorm different kinds of waste that is generated each day. Examples are glass, aluminum cans, paper, cardboard, plastics, food scraps, engine oil, old clothes, etc.

3. Without revealing any strategies or costs (see data sheets), have each group decide and record what they will do with each of the different kinds of waste for the first two weeks without garbage service. (15 minutes.)

4. Have each group report their solutions to the class.

5. Using the data sheet information discuss impacts and reveal "cost." If strategies come up that are not listed, make up a cost that is in keeping with those listed.

6. Have the groups decide on solutions for the next two weeks using the information they just gained. Allow 10 to 15 minutes.

7. Evaluate costs again and discuss changes that were made.

FOR DISCUSSUON:

1. How does your community actually deal with its waste?
2. Why have we chosen the methods we have? Is it because of necessity, convenience, lack of understanding, or____________?
3. What would it take to change people's "throwaway" habits? Be specific and have students develop some strategies that are realistic and fair.

EXTENSIONS:

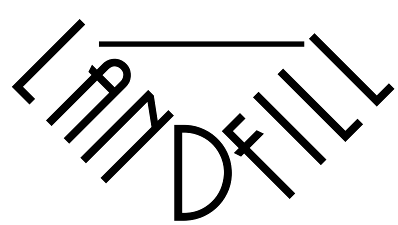
1. Start recycling in the classroom or school. Make separate containers to hold only writing paper that has been used on only one side, along with seperate containers for other used paper, lunch bags, newspaper (from home and faculty lounges), aluminum cans, and glass.

2. Have students set up recycling containers at home and bring in the recyclables once a week. For instance: Monday - newspaper; Tuesday - aluminum; Wednesday - glass; Thursday - paper; Friday - field trip to recycling center.

3. Have a party or go on a field trip with the money from recycling.

4. Have a speaker from the county waste management office come talk to the class.

5. Have your class, instead of the grounds keepers, pick up all campus litter for a week and discuss the students' reactions.



GARBAGE DATA SHEET

POSSIBLE STRATEGY	RAISIN COST	WHY
1. Store in plastic garbage bags until garbage service resumes again and can take it to the dump. (All types)	3 per item	Plastic bags are made of petroleum, a nonrenewable resource, and will never decompose. Garbage trucks need a lot of fuel, which is a nonrenewable resource.
2. Separate, save, and take to the recycling center. (Glass, cans, paper, oil)	0	You are using materials and preventing new materials from having to be mined or cut. If you use a car to go to the recycling center, car-pool to save gas.
3. Build a compost pile with scrap wood for your garden. (Food scraps)	0	You can use the compost to grow your own food. You are returning nutrients to the soil.
4. Take it to the woods and dump it. (All types)	6 per item	Decomposes slowly if at all. Can kill animals and pollute. Materials can seep into the water table and effect water quality.
5. Burn it. (Glass, cans)	—	Will not burn, please try again?
6. Burn it, (paper, food, clothes)	2 per item	Smoke pollutes the air, hurting plants and animals. Could increase greenhouse effect. Smoke can cause acid rain.
7. Burn it. (Plastics, oil)	6 per item	Burning petroleum produces and releases poisons into the air, which enter the water, air, and soil cycles.
8. Flush it down the toilet. (Food scraps)	3 per item	You are depleting the soil of nutrients and overloading the sewer.
9. Plan to use fewer throw-away products by: a) not buying things wrapped in plastics or other non-degradable packaging, b) buying things in containers that can be reused, c) growing or making as much as you can.	You're awarded 5!	You have solved the problem by preventing it from happening in the first place!

PENCIL AND PAPER ACTIVITIES

GARBAGE DATA RECORDING SHEET

TYPES OF GARBAGE	POSSIBLE SOLUTIONS	COST IN RAISINS
Glass		
Cans		
Paper		
Plastics		
Food		
Engine oil		
Old clothes		
ROUND 2		
Glass		
Cans		
Paper		
Plastics		
Food		
Engine oil		
Old clothes		

Answer these questions on the back of this page.

1. What was your most expensive solution?
2. Why was it so expensive?
3. What was your least expensive solution?
4. Why was it inexpensive?
5. Does your family use expensive or inexpensive ways to take care of your garbage?
6. What other ways can you use at home?
7. Does your school use expensive or inexpensive ways to take care of garbage?
8. What other ways can you use at school?

NAME ______________________ DATE ______________________

HOW MANY SYLLABLES?

Put these recycling words in the correct row.

Conserve	Aluminum	Glass	Newspaper	Cardboard
Litter	Garbage	Plastic	Styrofoam	Compost
Tin	Metals	Landfill	Recycle	Energy

One syllable	Two syllables	Three Syllables	More than Three Syllables

NAME ____________________ DATE ____________________

DIRECTIONS:

Each sentence below contains a misspelled word. Circle the misspelled word and write it correctly on the line at the right of each sentence.

Renewable and Nonrenewable Energy.

1. The wind is one of the renewible energy sources that has been used for a long time. ____________________

2. Solar enargy is something that will be around for five billion years. ____________________

3. Recycling saves mony and natural resources. ____________________

4. If we composted all gardan trimmings, there would be a lot less garbage at the dump. ____________________

5. Buying soda in recyclable bottls gets you the most soda for your money. ____________________

6. If you recycle, it will mean there is less garbege to take out to the trash can. ____________________

7. Some schools and clubs make money by recycleing.

8 Recycling paper savs trees. ____________________

9 If you recycle an aloominum can, it will take half as much energy to make a new one. ____________________

10. It takes energie to get energie. ____________________

garbage

ENERGY ETHICS

These activities will help students realize that each and every one of them can make a difference. Individuals will solve our energy problems. While it may seem like the nebulous, "they" are the ones who need to pass laws or quit polluting; it will be us, the individuals, who will write letters to, and cast votes for, the lawmakers. Likewise, individuals who ride the bus or a bike, instead of driving their own cars will make a difference. The sum of our individual, daily decisions determines the net outcome of the world's energy use. We don't want to preach perfection, but we do want to encourage honest effort. Each person, as an individual, will have to determine their own limits.

"Wants vs. Needs" is an activity that encourages students to reconsider some energy uses that are often taken for granted. One out of 10 gallons of oil burned in the world is burned on the roads of the United States! "Pretzel Hog" is an activity that explores this energy use for transportation. "United Nations Simulation" will help students get an idea of the problems that the world faces in dealing with resource distribution.

WANT VS. NEEDS

OBJECTIVES: Students will gain perspective on the necessity of various appliances.

SUMMARY: Through an interview and discussion with grandparents or senior citizens, the students will examine the need and use of modern-day electrical appliances and energy compared to earlier generations.

GROUPING: Individual or entire class.

TIME: One hour discussion, 1-1/2 hours on day of interview, 1/2 hour follow-up.

SUBJECTS: History, social studies, language arts.

VOCABULARY: Appliance.

MATERIALS: A copy of each worksheet per student.

PREPARATION AND BACKGROUND: We often forget that people used to get along without a lot of the energy-consuming appliances we use everyday. How could we get by without computers? How could we dry out hair without hair dryers? Our grandparents and other senior citizens have been around long enough to give us some perspective on this topic. With some thought, we can start to appreciate exactly what these conveniences do for us and at what cost.

appliance

PROCEDURE:

1. Go over the list of appliances on Worksheet Two with the students, exploring the energy source used for each appliance. Ask the students:

- What are the main sources of energy in the home? (electricity and natural gas)
- What is the original source of energy used to produce electricity? (oil, coal, geothermal, solar , wind, nuclear, hydro)
- Will there always be oil?
- Are there any bad effects of using oil?
- Have people always used oil?
- What did they use instead?
- How can we find out what they used, instead? (interview.)

2. After the discussion mentioned in the preparation section, have the students compose their own questionnaire for the grandparent or senior citizen interview or review the questionnaire provided and how to fill it in. Explain that they may have to be patient and be careful to speak clearly and loudly. Suggest that some students may want to use a tape or video recorder. Remind the students to thank the person for the interview.
3. Have the students fill out column one of worksheet.
4. Then have them conduct the interview, preferably with a person two generations older than the student. Make sure they fill out Worksheet One and column two of Worksheet Two during the interview.
5. After the interview, or in class, have them fill out column three on Worksheet Two and Worksheet Three.

FOR DISCUSSUON:

1. If power failure occurred and the government declared that you could only use five appliances in the next year, what five would you use?
2. Which appliances save time? Save energy?
3. What are the costs of ourconveniences?

EXTENSIONS:

1. Divide the class into groups of 3-5 students and have them discuss their interviews and write up a story, "Energy In Times Past," for presentation to the class.
2. Have a senior citizen come to the class, instead of a personal interview. Students may write up reports on the interview for the school paper.

WANTS VERSES NEEDS WORKSHEET #1

Date____________________

Names of interviewers: ____

____

____

____

Name of person being interviewed: ____

Age: _ ___40-50 yrs ____51-60 yrs ____ 61-70 yrs ____71-80 yrs ____81-90 yrs

1. Where did the person live when they were your age?______________________________

____

____

____

____

2. In a country area or a city area?____

____

____

____

3. How might their home life have been affected their energy use?______________________

____

____

____

____

4. Did they have every thing they needed?____

5. What are the biggest differences between your energy use and theirs?_______________

____

____

____

____

____

____

____

WANTS VERSES NEEDS WORKSHEET #2

ELECTRICAL APPLIANCE	IS IT IN YOUR HOME NOW?	WAS IT IN YOUR HOME WHEN YOU WERE A CHILD?	WHAT WAS USED INSTEAD?
Television			
Tape player			
Stereo			
V.C.R.			
Home computer			
Fans			
Space heating			
Air conditioner			
Electric blanket			
Hot water heater			
Radiator			
Space heater			
Lamps			
Night light			
Mosquito zapper			
Toaster			
Electric teakettle			
Coffee maker			
Coffee grinder			
Electric mixer			
Food processor			
Electric can opener			
Microwave oven			
Electric oven			
Vacuum			
Washing machine			
Clothes dryer			
Dishwasher			
Blow dryer			
Curling iron			
Electric toothbrush			
Clothes iron			

WANTS VERSES NEEDS WORKSHEET #3

1. Do you use less, more, or the same number of electrical appliances as the person you interviewed?

2. Was there a particular group of appliances that you use, that they did not use as much?

3. If you could only keep five electrical appliances, which would you choose? Why?

4. If there was no electricity, how would you
   Cook your food?

   Wash dishes

   Store food in the summer?

   Have lights in the winter?

   Entertain yourself?

PRETZEL HOG

OBJECTIVES: Students will use decision-making techniques to determine which forms of transportation conserve energy, and how they can implement them in their daily life.

SUMMARY: Students will examine the energy costs of different forms of transportation used around the world to get from home, to school, to town.

GROUPING: Entire class as individuals and some as small groups.

TIME: 30 minutes for introduction; 30 minutes. per round.

SUBJECTS: P.E. and social studies.

VOCABULARY: CitizenO
vocate and conservation.

MATERIALS:

- 10 energy tokens per student — pretzels, popcorn, beans, or cards.
- Three signs, one for each station, (home, school, town).
- One copy of the question-worksheet per student.
- Optional: one copy of the data-recording sheet per student.

PREPARATION AND BACKGROUND: Different modes of transportation require different fuels. The various fuels have varied costs. In this activity, students will "pay" (in pretzels) for "transporting" themselves to and from home and school. They will be charged at varied rates, depending on the mode of transportation they choose (see "pretzel Hog Data Sheet").

Before starting, it is important to discuss transportation with the students. Ask them what different forms of transportation they use to get to and from school each day. (With your students, you will be generating a copy of some of the information on the "Pretzel Hog Data Sheet.") So brainstorm other forms of transportation used throughout the world, listing them on the chalkboard. For example, in Europe one might use a train and in South America one might use a horse. (See data sheet for more ideas.) List where various forms of transportation are used throughout the world. (See data sheet for ideas.) Discuss and list the different forms of energy each mode of transportation uses. Note on your list which forms of transportation are used throughout the world. (See data sheet for ideas.) Discuss and list the different forms of energy each mode of transportation uses. Note on your list which forms of transportation use renewable energy sources and which use non-renewable energy sources. Talk about how many people can ride in each form of transportation. For instance, two people can ride a horse, and several can ride in a bus.

When you set out the "home," "school," and "town" stations, they should be 134 student-sized steps apart. This number insures the appropriate expenditure of pretzels for the lesson. NOTE: This information will be important for doing the activity. In round one, it takes a minimum of 40 steps per pretzel to make it to the end alone. For the following rounds, it takes a minimum of 50 steps per pretzel. After round two students should be pairing up or forming small groups (to represent riders in a bus or on a train) for everyone to make it through. For example, the airplane needs a minimum of nine people to share their transportation energy tokens in order to get to the end.

PROCEDURE:

1. Introduce the activity and have students set up the three stations. They must be 134 steps apart.

2. Distribute 10 energy tokens per student, stressing that the idea is to conserve your energy, and if you eat it or lose it, the energy is gone.

3. For round one, everyone uses the form of transportation they used to get to school today. Reveal the number of steps each energy token is worth depending on the transportation from used. This is easier if you are using pre-made energy cards that represent a specific mode of transportation. Explain that everyone will start at home, then go to school, and pay their transportation costs appropriately. You may want to assign some students to be "fuel-toll-token collectors." Next they go to town, again paying their transportation costs upon arrival. Next, if they can afford it, they go back home using the same from of transportation for each leg of the trip.

4. At the end of the round, have people pay up, then discuss who made it back home and why.

5. In round two, students choose any mode of transportation they want and travel the same route as round one.

6. In round two, students can again choose any mode of transportation they want, but this time students are only allowed eight tokens. They may need a bit of help to figure out that they need to use mass transit and carpooling. Make the goal be getting everyone in the class through the course.

7. Round four is the same as round three

8. For round five, have the students choose any mode of transportation that is realistic for them.

FOR DISCUSSION:

1. Who got through each round successfully and why?

2. Who did not get through a round? What are some ways students could have made it?

3. What were the transportation forms that conserved the most energy?

4. How can you conserve energy in the transportation you use daily?

EXTENSIONS:

1. Have students make the signs for home, school and town.

2. Have students research different forms of energy used around the world.

3. Record and graph how much energy was used per round and how much was saved.

4. Have students brainstorm different ways their town could use alternative transportation to conserve energy.

PRETZEL HOG DATA SHEET

FORM OF TRANSPORT	PRIMARY ENERGY SOURCE	RENEWABLE OR NON	# OF RIDERS	STEPS FOR PRETZEL	# PEOPLE NEEDED	WHERE USED
walk	food	R	1	55	1	world
bus	oil	NR	40	20	3	roads
bike	food	R	1-2	50	1	paths
burro	food	R	1-2	40	2	N America
horse	food	R	1-2	40	2	N&S America
Train	oil	NR	60	20	3	Europe
Rickshaw	food	R	1-2	40	2	China
Elephant	food	R	1-2	30	2	India
Dog sled	food	R	1-2	30	2	Alaska
Airplane	oil	NR	300	5	8	world
Car	oil	NR	2-8	10	4	developed Countries
VARIOUS CAR MODEL						
Dodge Van 15 mpg	oil	NR	8	3	8	“
Toyota AXV 98 mpg (prototype)	“	“	4	10	4	“
Ford Escort	“	“	4	10	4	“

PRETZEL HOG DATA RECORDING SHEET

round #	transportation chosen	renewable or non-reneqable	# of passengers	# of pretzels useds	# of steps taken
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

PRETZEL HOG QUESTION SHEET

1. Which modes of travel cost the most? ______________________________
Why? ____

____

2. Which modes of transportation cost the least? ________________________
Why? ____

____

3. Which modes of transportation used nonrenewable energy?_________________

____

4. Which modes of energy used renewable energy?________________________

____

5. Which modes of travel, renewable or nonrenewable energy, is the most expensive?

____

Why?____

____

6. Which modes of transportation did you choose?________________________

____

Why?____

____

7. Which modes of travel do you usually use?____________________________

____

8. Which modes of travel will you use in the future?______________________

____

____

U. N. SIMULATION

OBJECTIVES: To demonstrate — in a dynamic: interactive way — how energy resources are distributed throughout the world and prepare students to think globally.

SUMMARY: Students role-play different members of the United Nations, debate, and decide how to distribute the world's energy resources.

GROUPING: See accompanying data sheet.

TIME: Be prepared. It can take anywhere from 2 to 4 days.

SUBJECT: Social studies, science, language arts.

VOCABULARY: United Nations, ambassador, Secretary General, distribution, allocation, Security Council, politician, economist, environmental scientist, consumer, renewable resources, nonrenewable resources.

MATERIALS: World map, pins, construction paper, scissors, prepared index cards, colored paper, or food and props.

PREPARATION AND BACKGROUND: This activity has all the ingredients of a powerful learning experience. Prepare for it well! Students simultaneously play the role of politician, farmer, economist, environmental scientist, business person, and consumer of a particular country. Natural resources will be represented by objects or tokens which you will collect or make up (see the data sheet that follows). Each student, or team of students, also represents a country and its quantity of resources today and in the future. Jose Antonio, for example, may represent India which has access to specific quantities of solar energy, food, garbage, and water; whereas Mohammed represents Saudi Arabia and controls only oil, but plenty of it. Whether or not energy distribution is fair or how it could be reworked are ethical questions which students will decide how to solve as the simulation progresses.

Set the mood. A United Nations simulation demands dignity, honor, and respect. Each student must be conscious of their role as a cultural ambassador.

Secretary General

United Nations

SECURITY COUNCIL

PROCEDURE:

1. Divide students into 11 countries. (See data sheet.) Each country represents a different region of the world.

2. Have students research information about their country. Possible subject areas include geography, geology, energy resources within their countries, energy resources used today and where they get them, the energy needs to the people in the country, and everything else you can find time to do.

3. Have representatives from the 11 countries locate their place on the world map.

4. As moderator, or Secretary General, set the tone. "Will the ambassador from Mexico please step forward and point out to the rest of the Assembly exactly where Mexico is located on the world map."

5. Discuss the information collected in the research. As Secretary General, point out how the origins of energy supplies may not correspond with their present distribution. (Examples include oil, gold, minerals, etc.)

6. Divide energy supplies (represented by objects or colored paper tokens) among the 11 regions according to the World Energy Distribution Chart. (See data sheet.)" Will the representative of the Soviet Union please step forward to collect your energy supplies."

7. Discuss the uneven distribution of resources. For Example, the U.S., which represents only 6% of the world's population, has less. Ask, "If most of you do not feel that this distribution is fair, what could we do about it?" Encourage a brainstorming of ideas.

8. Explain that twe have two ways of dealing with energy supply allocation — the United Nations and the open market.

ROUND ONE: United Nations world conference simulation (20 minutes).

1. Each nation will try to develop a plan to re-allocate and redistribute world energy resources in a manner fair to all. (5 minutes.)

2. Have one representative from each country, or region, propose their plan at a UN General Assembly.

3. The catch is that the whole UN must accept any plan by a two-thirds majority, and more over, any nation in the Security Council (U.S. Great Britain, Soviet Union, or China) can veto any plan.

ROUND TWO: Open Market Free Enterprise Simulation (20 minutes).

1. Nations trade their resources any way they wish. Anything goes, including exploiting, dominating, or simply ignoring lesser political and economic powers. Benevolence and "care packages" are also permissible, Big regions can use energy supplies, economic, and political clout to influence how the trading takes place.

2. Discuss what happened? Where were resources traded? Was trading important? Was anything really accomplished by the UN? Was that meeting fair?

ROUND THREE: United Nations World Conference Simulation wilthout nonrenewable resourcess.

1. The same as round one, except this time all the nonrenewable resources, for it is now 150 years later, have run out. Also. this time everyone except the Security Council has veto power. If time permits, follow with round two again.

distribution

FOR DISCUSSION:

1. How and why were resources traded differently?

2. What changed between the different rounds?

3. What worked the best? What did not work?

4. How could the process be more fair?

5. How does geography relate to energy resources?

EXTENSIONS:

1. Make cutouts of each country from construction paper to pin on the world map. Decorate the cutouts with information found in the research.

2. Repeat the simulation between two countries. Each student representing a farmer, politician, environmental scientist, etc.

politition

Ambassador

economist

ENVIRONMENTAL SCIENTIST

3. Videotape the simulation and view it as you answer the discussion questions.

UNITED NATIONS SIMULATION DATA SHEET

DISTRIBUTUON OF COUNTRY REPRESENTATIVES TO THE UNITED NATIONS

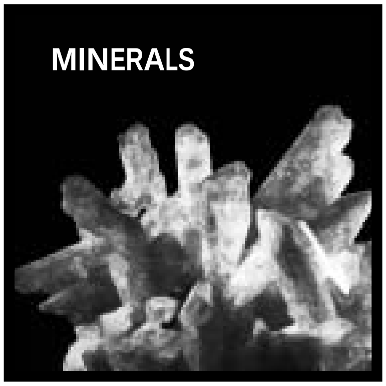
# of students	% of world population	country/region represented
2	8%	U.S. (North America)
1	4%	Mexico (Central America)
1	4%	Brazil (South America)
3	12%	Soviet Union (Eastern Europe)
2	8%	Great Britain (Western Europe)
1	4%	Saudi Arabia (Middle East)
1	4%	Kenya (Africa)
1	4%	South Africa(Southern Africa)
5-6	22%	India (South Asia)
6-7	26%	China (Southeast Asia)
1	4%	Japan (South Pacific
Totals 24-26	100%	

WORLD ENERGY DISTRIBUTION IN PERCENTAGES

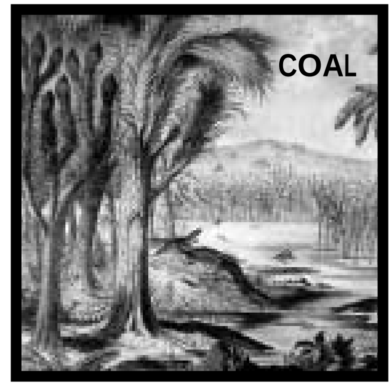
Nations	Minerals	Oils	Wood	Uranium	Solar	Biomass	Coal	Garbage	Water	Gold
U.S.A.	15	20	25	55	10	40	25	lots	lots	20
USSR	15	15	20	5	5	10	30	lots	lots	15
Japan	15	15	15		10	5	5	lots	little	10
W. Europe	15	10	20	15	10	5	5	lots	lots	25
Africa	5		5		10			lots	little	
S. Africa	15			15	5	5	5	lots	little	5
Brazil	5		10		5	5		lots	little	5
Mexico		10	5		10	5		lots	little	5
India				5	10	5		lots	middle	5
China				5	10	10	25	lots	middle	
Middle East		30			5	5		lots	little	10

Paper color	orange	grey	brown	red	yellow	green	black	purple	blue	gold
Food	cookie	nickels	apple	pepper	orange	celery	raisin	popcorn	water	corn chips

a.l.l.o.c.a.t.i.o.n


MINERALS


WATER

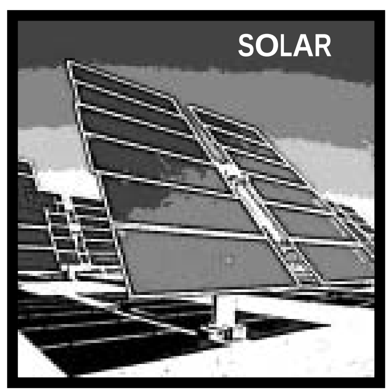

COAL


GARBAGE

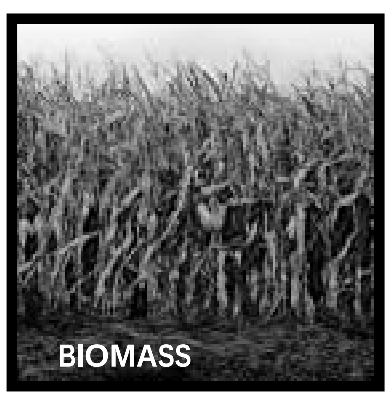

TREES


NUCLEAR


OIL


SOLAR


GOLD


BIOMASS

PENCIL AND PAPER ACTIVITIES

UNITED NATIONS SIMULATION QUESTION SHEET

1. Which nation do you represent? ______________________________

2. What energy supplies do you have? ______________________________

3. Which countries did you trade energy with? ______________________________

4. Did all the countries have enough energy supplies? ______________________________

5. Which countries did not have enough? ______________________________

6. What happened to those countries? ______________________________

7. Is it fair for some countries to have more energy supplies than other countries? ______

Why? ______________________________

8. What would you do about the energy distribution and people's energy needs? ______

NAME ______________________________ DATE ______________________________

Many people do not understand what the energy crisis is all about. A study of 1,300 adults between the ages of 26 and 35 showed the following results.

DIRECTIONS: Find out how many people the percentages represents. First, change the percentages to decimals. Then, multiply by the actual number of people who answered the questions, 1,300.

1. Only 46% of the people knew that crude oil produced the largest amount of energy used in the United States. How many people knew this?

   First, change 46% to .46, now you can multiply by the number of people in the survey, 1300.

$$\begin{array}{r} 1300 \\ \underline{\times .46} \end{array}$$

   After you do the math write out the answer in a sentence, like this. __________ people knew that crude oil produced the largest amount of energy.

2. Only 14% of the people knew that coal is the main fuel source used to produce electricity. How many people knew this?

3. Just 16% of the people knew that gasoline can be made from coal. How many people knew this?

4. Only 49% of the people knew that the fossil fuel we have most of is coal. How many people knew this?

5. Only 33% realized that Americans, who represent 5% of the world's population, use more than 60% of the world's natural resources. How many people realized this?

6. If you were in this survey, would you have known these energy facts?

NAME______________________ DATE ______________

Saving electricity makes "cents"......

Below is an energy chart from PG&E (Pacific Gas and Electric company), which shows how much electricity in kilowatt hours (kWh) it takes to use these electrical appliances.

Using the 1989 rate of $.10 per kWh, figure out the costs to operate these appliances and put a check mark in front of the ones you use in your home.

APPLIANCE	ESTIMATED USE	ENERGY COST
Coffee maker	1/4 kWh per pot	_______per pot
Deep fryer	1 kWh per hour	_______per hour
Frying pan	1/2 kWh per hour	_______per hour
Oven, self cleaning	10 kWh per cleaning	_______per clean
Range	1 kWh per meal	_______per meal
Refrigerator, frostless	5 kWh per day	_______per day
Refrigerator, manual	2 kWh per day	_______per day
Waffle Iron	1/2 kWh per day	_______per use
Clothes dryer	6 kWh per load	_______per load
Washing machine	3 kWh per load	_______per load
Water heater	26kwh per day	_______per day
Waterbed heater	6 kWh per night	_______per night
Space heater	1 1/2 kWh per hour	_______per hour

Which costs more to operate, a frost-less or manual refrigerator?

How much does it cost to heat a waterbed for one month (30 days)?

How much does it cost to heat water for your home for one month?

ENERGY GLOSSARY

ABSORBER or ABSORBER PLATE: A surface, usually blackened metal, in a solar collector, which absorbs solar radiation.

ACTIVE SOLAR SYSTEM: A solar energy collecting system that uses mechanical means such as motors, pumps, valves, etc., to operate. (See PASSIVE SOLAR SYSTEM.)

ALTERNATING CURRENT (AC) An electric current whose direction of flow changes at periodic, regular intervals. In the U.S., it changes direction 60 times per second.

AMBIENT TEMPERATURE: Temperature of surrounding air/atmosphere/environment.

AQUIFER: An underground bed or stratum of earth, gravel, or porous stone that contains water.

ATOM: The smallest particle of an element that contains all of its physical and chemical properties. Atoms combine to from MOLECULES. COMPOUNDS are molecules containing more than one kind of atom.

BARREL (BBL,) A unit of measure used for quantities of oil, equal to 42 U.S. gallons. One barrel of crude oil has about the same amount of energy as 350 pounds of coal, or 5.8 million Btus.

BIOCONVERSION: The conversion of animal, plant or other waste into usable fuel.

BIOMASS: Organic, usually plant, material.

BREEDER REACTOR: A nuclear chain reactor in which more fissionable atoms are formed than were originally used.

BRITISH THERMAL UNIT (Btu): A quantity of heat required to raise the temperature of one pound of water 1°Fahrenheit.

CALORIE: The amount of heat needed to raise the temperature of one gram of water 1°Celsius. Food energy is measured in calories. (Kilocalories equal 1000 calories).

CHAIN REACTION: A reaction that stimulates its own repetition. Chemical reactions require energy to occur. In a nuclear fission reaction, the splitting of atoms provides energy for other reactions.

CONDUCTION (OF HEAT): The transmission of energy directly from molecule to molecule.

CONDUCTIVITY: The ease with which heat (for electricity) moves through a material. Materials such as copper and glass are good conductors of heat, while insulating materials are poor conductors of heat. Metals generally are good electrical conductors, while most non-metals are poor electrical conductors.

CONSERVATION OF MATTER AND ENERGY (LAW OF): Matter and energy are interchangeable, but THE TOTAL AMOUNT OF MATTER AND ENERGY IN THE UNIVERSE REMAINS CONSTANT. Essentially, this means that we can neither create nor destroy energy, but we can change it from one form to another.

CONVECTION: The transfer of energy by moving masses of matter (liquid or gas). Also, the movement of heat energy from a (relatively) warm surface to a (relatively) cool surface.

CRITICAL MASS: The minimum amount of fissionable material required to start a chain reaction.

DECAY: See RADIOACTIVE DECAY

EFFICIENCY: The ratio of useful work performed (by a machine) to the energy used in the process.

ENERGY: The capability of doing work (moving a mass over a distance). POTENTIAL ENERGY is the energy due to the position of a body with respect to another position (e.g. a book on a table has more potential energy than one on the floor. A log has more chemical potential energy than the ashes formed when the log burns.) KINETIC ENERGY is due to motion. (A rapidly flowing stream has more kinetic energy than the same water resting in a lake.)

FISSION: The splitting of atoms, which results in the release of large amounts of energy and also the production of "daughter" atoms.

FOSSIL FUELS: Coal, oil, natural gas, and other fuels originating from geologic deposits of ancient plant and animal life.

FUSION (ATOMIC): A nuclear reaction involving the combination of smaller atomic nuclei or particles to form larger ones, with the release of energy from mass transformation. (This process is called the "thermonuclear reaction" due to the extremely high temperature required to start it.)

GEOTHERMAL ENERGY: Heat available in the earth's subsurface. Believed to have been produced by natural radioactivity. In a deep well or mine, the temperature increases about 1°F/100 feet of depth. This heat energy can be used to boil water, thus producing steam to drive turbines/generators.

GREENHOUSE EFFECT: The heating of the earth's atmosphere due to an accumulation of carbon dioxide, which is produced by the burning of fossil fuels, et al.

GROUNDWATER: Water within the earth. It supplies wells and springs. (See AQUIFER)

HALF LIFE: The amount of time that it takes one-half of a radioactive element's atoms to decay or break down into their daughter atoms. The daughter atoms may, in turn, be radioactive with half lives of their own. Each radioactive element or ion has its own half life, ranging from a fraction of a second to thousands of years.

HEAT CAPACITY: The amount of heat required to change the temperature of a cubic centimeter of a substance by 1°Celsius. Substances with high heat capacities (such as water) require a lot of heat to increase their temperatures and also store much heat. Heat capacity is equal to specific heat (see definition) times density.

HYDROCARBON: Pertaining to electricity produced by a water-powered turbine/generator.

INSOLATION: The rate of solar radiation received per unit area.

INSULATION: The prevention of the transference of heat, sound, or electricity.

KILOWATT (kW): a UNIT OF POWER EQUAL TO 1000 WATTS OR 1.3414 HORSEPOWER. One kW is capable of raising the temperature of about a pint of water 1°Fahrenheit in one second, roughly.

KILOWATT-HOUR (kWh): A unit of work or energy equal to that expanded by one kW in one hour, also equal to 3,413 BTU's.

MOLECULE: The smallest part of a substance that has the properties of the substance. Usually considered to be made up of more than one atom. The atoms may be of the same type (e.g. O) or of more than one type (e.g. HO).

NATURAL GAS: Naturally occurring mixtures of hydrocarbon bases and other vapors. Sometimes found associated with oil.

NONRENEWABLE RESOURCE: Resource (such as oil, coal, natural gas, uranium) that is not re-usable or not naturally replaced as quickly as we use it up (See renewable resource).

NUCLEAR FISSION: See FISSION.

OPEC (ORGANIZATION OF PETROLEUM EXPORTING COUNTRIES): An organization of countries in the Middle East, North America, and South America, which was formed to develop common oil-marketing policies (including production quotas, prices).

PASSIVE SOLAR SYSTEM: A system that utilizes solar energy without using mechanical (energy using) devices (e.g. south-facing windows, storage masses, etc.) (See ACTIVE SOLAR SYSTEM).

PHOTOVOLTAIC: A device or system that converts solar energy into electricity. (See SOLAR CELL).

R-VALUE: Resistance to heat flow. The higher the R-value, the better the insulation.

RADIOACTIVE DECAY: Spontaneous breakdown of unstable atoms. (See HALF-LIFE).

RENEWABLR RESOURCES: Non-depletableO resources that we cannot use up, such as the sun, or resources that can be replaced, such as biofuels. (Contrast to NONRENEWABLE RESOURCES)

SOLAR CELL: The basic energy collecting and transforming unit of a photovoltaic device.

SPECIFIC HEAT: The ratio of the amount of heat added or removed from a substance to unit mass per degree of temperature change in degrees Celsius. (Compare with HEAT CAPACITY).

THERMAL POLLUTION: Degradation of water quality by the introduction of heated water, especially from industrial processes and electrical power generation.

THERMODYNAMICS: The science and study of the relationship between heat and mechanical work.

THERMOSTAT: A temperature sensitive device that turns heating and cooling equipment on and off at set temperatures.